User Manual
SONO-MIX MINI

IMKO Micromodultechnik GmbH
Im Stöck 2
D - 76275 Ettlingen

Telefon: +49 - (0)7243 - 5921 - 0
Fax: +49 - (0)7243 - 90856
e-mail: info@imko.de
http: //www.imko.de

User Manual for SONO-MIX MINI

As of 10th September 2014

Thank you for buying an IMKO moisture probe.
Please carefully read these instructions in order to achieve best possible results with your mixer probe SONO-MIX MINI for the in-line moisture measurement in sand, gravel, fresh concrete or any other material. Should you have any questions or suggestions regarding your new mixer probe after reading, please do not hesitate to contact our authorised dealers or IMKO directly. We will gladly help you.

List of Content

1. Instrument Description SONO-MIX MINI 4

1.1.1. The patented TRIME® TDR-Measuring Method 4

1.1.2. TRIME® compared to other Measuring Methods 4

1.1.3. Areas of Application 4

1.2. Mode of Operation 5

1.2.1. Measurement Values with physically Pre-check, Average Value and Filtering 5

1.2.2. Auto-Correction at Abrasion 5

1.2.3. Determination of the Cement Concentration 5

1.2.4. Temperature Measurement 5

1.2.5. Analogue Outputs for Measurement Values 6

1.2.1. The serial RS485 and IMP-Bus interface 6

1.2.2. The IMP-Bus as a user friendly network system 7

1.2.3. Error Reports and Error Messages 7

2. Configuration of the Measure Mode 8

2.1. Operation Mode CA and CF at non-continuous Material Flow 8

2.1.1. *Average Time* in the measurement mode CA and CF 10

2.1.2. Filtering at material gaps in mode CA and CF 10

2.1.3. Mode CC – automatic summation of a moisture quantity during one batch process . 18

2.1.4. Mode CH – Automatic Moisture Measurement in one Batch 19

2.2. Overview of single modes for different applications 13

2.2.1. Calibration of SONO-MIX MINI in a mixing plant 14

2.2.2. Shortest expecting mixing times and density effects at partial loads 14

2.2.3. How to perform a calibration with SONO-MIX MINI for determination of water content, in 3 easy steps 15

2.2.4. SONO-MIX MINI to control the water/cement ratio 17

2.2.5. Mode CC – automatic summation of a moisture quantity during one batch process . 17

2.3. Overview of single modes for different applications 20

3. Calibration Curves 21

3.1.1. SONO-MIX MINI for measuring Moisture of Sand and Aggregates 24
3.2. Creating a linear Calibration Curve for a specific Material 25
3.2.1. Nonlinear calibration curves 25
4. Connectivity to SONO Probes 27
4.1.1. Connection Plug and Plug Pinning 28
4.1.2. Analogue Output 0..10V with a Shunt-Resistor 29
4.1.3. Connection diagram with SONO-VIEW 29
4.2. Connection of the Probe to the SM-USB Module from IMKO 31
5. Quick Guide for the Commissioning Software SONO-CONFIG 33
5.1.1. Scan of connected SONO probes on the serial interface 33
5.1.2. Configuration of Measure Mode and serial SONO-interface 34
5.1.3. Analogue outputs of the SONO probe 34
5.1.4. Selection of the individual Calibration Curves 35
5.1.5. “Test” run in the respective Measurement Mode 36
5.1.6. “Measure” run in Datalogger-Operation 36
5.1.7. Basic Balancing in Air and Water 37
6. Installation of the Probe 38
6.1. Assembly Instructions 38
6.2. Assembly Dimensions 39
6.3. Mounting in curved Surfaces 40
6.4. Probe Adjustment 41
6.5. Exchange of the Probe Head 42
6.5.1. Basic Balancing of a new Probe Head 43
7. TECHNICAL DATA SONO-MIX MINI 44

1. Instrument Description SONO-MIX MINI

1.1.1. The patented TRIME® TDR-Measuring Method

The TDR technology (**T**ime-**D**omain-**R**eflectometry) is a radar-based dielectric measuring procedure at which the transit times of electromagnetic pulses for the measurement of dielectricity constants, respectively the moisture content are determined.

The SONO-MIX MINI Mixer Probe consists of a high grade steel casing with a wear-resistant sensor head made of hardened steel and ceramic. An integrated TRIME TDR measuring transducer is installed into the casing. A high frequency TDR pulse (1GHz), passes along wave guides and generates an electro-magnetic field around these guides and herewith also in the material surrounding the probe. Using a new patented measuring method, IMKO has achieved to measure the transit time of this pulse with a resolution of 1 picosecond ($1x10^{-12}$), consequently determine the moisture and to provide information in regard to the concrete composition.

The established moisture content, as well as the concrete composition, respectively the temperature, can either be uploaded directly into a SPC via two analogue outputs 0(4)...20mA or recalled via a serial interface.

1.1.2. TRIME® compared to other Measuring Methods

In contrary to conventional capacitive or microwave measuring methods, the TRIME® technology (**T**ime-Domain-**R**eflectometry with **I**ntelligent **M**icromodule **E**lements) does not only enable the measuring of the moisture but also to verify if the cement content specified in a recipe has been complied with. This means more reliability at the mixing fresh concrete.

TRIME-TDR technology operates in the ideal frequency range between 600MHz and 1,2 GHz. Capacitive measuring methods (also referred to as Frequency-Domain-Technology) , depending on the device, operate within a frequency range between 5MHz and 40MHz and are therefore prone to interference due to disturbance such as the temperature and the mineral contents of the measured material. Microwave measuring systems operate with high frequencies >2GHz. At these frequencies, nonlinearities are generated which require very complex compensation. For this reason, microwave measuring methods are more sensitive in regard to temperature variation.

SONO probes calibrate themselves in the event of abrasion due to a novel and innovative probe design. This consequently means longer maintenance intervals and, at the same time, more precise measurement values.

The quality of fresh concrete is the decisive factor for the stability and the durability of concrete constructions. Hereby, the two parameters moisture and cement content assume a central role as these determine the consistency and the desired mechanical stability of concrete. The measurement of these two basic parameters therefore warrant for ideal quality and durability.

SONO-MIX MINI accurately measures both in the dry mixture and in the wet mixture. A "dry mixture" can e.g. be mixed with residual water varying solids content so that the water content to 70% target is met. The remaining 30% clean water content can then be dosed with SONO-MIX MINI precisely.

1.1.3. Areas of Application

The SONO-MIX MINI mixer probe is suited for installation into intensive mixers and chutes and other plant technologies.

1.2. Mode of Operation

1.2.1. Measurement Values with physically Pre-check, Average Value and Filtering

SONO probes measure internally at very high cycle rates of 10 kHz and update the measurement value at a cycle time of 250 milliseconds at the analogue output. In these 250 milliseconds a probe-internal pre-check of the moisture values is already carried out, i.e. only plausible and physically checked and pre-averaged single measurement values are be used for the further data processing. This increases the reliability for the recording of the measured values to a downstream control system significantly. In the **Measurement Mode CS** (Cyclic-Successive), an average value is not accumulated and the cycle time here is 250 milliseconds. In the **Measurement Mode CA, CF or CK**, not the momentarily measured individual values are directly issued, but the average value is accumulated via a variable number of measurements (Average) in order to filter out temporary variations. These variations can be caused by inhomogeneous moisture distribution in the material surrounding the sensor head. The delivery scope of the SONO-MIX MINI includes suited parameters for the averaging period and a universally applicable filter function deployable for currently usual applications. The time for the average value accumulation, as well as various filter functions, can be adjusted for special applications.

1.2.2. Auto-Correction at Abrasion

Even in the event of abrasion at the probe head of a SONO probe, the automatic measurement compensation enables significantly longer operating periods without the necessity of recalibration. Many other probes deployed for the material moisture measurement are equipped with a dielectric screen (ceramic or plastic plate). If this screen is exposed to wear and a regular recalibration is not conducted, these probes will provide faulty measurement values as the intensity of the measuring field subsequently increases due to the wear. At the SONO series with the TRIME TDR radar-based method, the innovative probe design ensures for the automatic correction of the sensor in case of changes to the dielectric screen caused by abrasion. This consequently means continuous reliability and longer maintenance intervals at the SONO probes.

1.2.3. Determination of the Cement Concentration

With the radar-based TRIME measurement method, it is now possible for the first time, not only to measure the moisture, but also to provide information regarding the conductivity, respectively the cement content, the expansion rate or the composition of a special material. Hereby, the attenuation of the radar pulse in the measured volume fraction of the material, e.g. fresh concrete, is determined. This novel and innovative technology measures the same amount of material as with the moisture measurement and delivers a radar-based conductance value (EC-TRIME **R**adar-**b**ased-**C**onductivity) in dS/m. EC-TRIME is a characteristic value which is determined in dependency of the cement concentration, respectively the water/cement ratio and is issued as an unscaled value. The EC-TRIME measurement range of the SONO-MIX MINI is 0..50dS/m.

1.2.4. Temperature Measurement

A temperature sensor is installed into the SONO-MIX MINI which establishes the casing temperature 5mm beneath the sensor head. The temperature can optionally be issued at the analogue output 2. As the TRIME electronics operate with a low power of approximately 1.5 W, the probe casing does slightly heat up. A measurement of the material temperature is therefore only possible to a certain degree. The material temperature can be determined after an external calibration and compensation of the sensor self-heating.

1.2.5. Analogue Outputs for Measurement Values

The measurement values are issued as a current signal via the analogue output. With the help of the service program **SONO-CONFIG,** the SONO-MIX MINI can be set to the two versions for either 0..20mA or 4..20mA. Furthermore, it is also possible to variably adjust the moisture dynamic range e.g. to 0-10%, **0-20%** or 0-30% or any other range. For a 0-10V DC voltage output, a 500R resistor can be installed in order to reach a 0..10V output.

Analogue Output 1: Moisture in % (variable adjustable)
Analogue Output 2: Wires are not occupied in the cable !!

Conductivity (EC-TRIME) or optionally the temperature.
In addition, there is also the option to split the analogue output 2 into two ranges: into 4..11mA for the temperature and 12..20mA for the conductivity. The analogue output 2 hereby changes over into an adjustable one-second cycle between these two (current) measurement windows.

For the analogue outputs 1 and 2 there are thus several adjustable options:

Analog Output: (two possible selections)

0..20mA **4..20mA**

Output Channel 1 and 2: (three possible selections)

1. **Moist, Temp.** Analogue output 1 for moisture, output 2 for temperature.
   or
2. **Moist, Conductivity** Analogue output 1 for moisture, output 2 for conductivity in a range of 0..50dS/m.
   or
3. **Moist, Temp/Conductivity** Analogue output 1 for moisture, output 2 for both, temperature and conductivity with an automatic current-window change.

For analogue output 1 and 2 the moisture dynamic range and temperature dynamic range can be variably adjusted. The moisture dynamic range should not exceed 100%

Moisture Range:
Maximum: e.g. 20 for sand (Set in %)
Minimum: 0

Temp. Range:
Maximum: 70 °C
Minimum: 0 °C

1.2.1. The serial RS485 and IMP-Bus interface

SONO-probes are equipped with a standard RS485 as well as the IMP-Bus interface to set and readout individual parameters or measurement values. An easy to implement data transfer protocol enables the connection of several sensors/probes at the RS485-Interface. In addition, SONO-probes can be directly connected via the module SM-USB or the display module SONO-VIEW to the USB port of a PC, in order to adjust individual measuring parameters or conduct calibrations.

Please consider: The initial default setting of the serial interface is pre-setted for the IMP-Bus. To operate with the RS485 inside the SONO-probe, it is necessary to switch and activate the RS485 interface with help of the modul SM-USB or SONO-VIEW.

In the download area of IMKO´s homepage www.imko.de we publish the transmission protocol of the SONO-probes.

1.2.2. The IMP-Bus as a user friendly network system

With external power supply on site for the SONO probes, a simple 2-wire cable can be used for the networking. By use of 4-wire cables, several probes can be also supplied with power.

Standard RS485-interfaces cause very often problems! They are not galvanically isolated and therefore raises the danger of mass grindings or interferences which can lead to considerably security problems. An RS485 network needs shielded and twisted pair cables, especially for long distances. Depending on the topology of the network, it is necessary to place 100Ohm termination resistors at sensitive locations. In practice this means considerable specialist effort and insurmountable problems.

The robust IMP-Bus ensures security. SONO-probes have in parallel to the standard RS485 interface the robust IMP-Bus which is galvanically isolated which means increased safety. The serial data line is isolated from the probe´s power supply and the complete sensor network is therefore independent from single ground potentials and different grid phases. Furthermore the IMP-Bus transmit its data packets not as voltage signals, but rather as current signals which also works at already existing longer cables. A special shielded cable is not necessary and also stub lines are no problem.

1.2.3. Error Reports and Error Messages

SONO probes are very fault-tolerant. This enables failure-free operation. Error messages can be recalled via the serial interface.

2. Configuration of the Measure Mode

The configuration of SONO- probe is preset in the factory before delivery. A process-related later optimisation of this device-internal setting is possible with the help of the service program **SONO-CONFIG**. For all activities regarding parameter setting and calibration the probe can be directly connected via the serial interface to the PC with the SM-USB-Module or the display module SONO-VIEW which are available from IMKO.

The following settings of SONO probes can be amended with the service program **SONO-CONFIG**:

Measurement-Mode and Parameters:

- Measurement Mode A-On-Request (only in network operation for the retrieval of measurement values via the RS485 interface).
- Measurement Mode C Cyclic:
  The SONO probe is supplied ex-factory with suited parameters in **Mode C**. Up to 6 different modes can be adjusted:

  Mode CS: (Cyclic-Successive) For very short measuring processes (e.g. 5…20 seconds) without floating average, with internal up to 100 measurements per second and a cycle time of 250 milliseconds at the analogue output. Measurement mode CS can also be used for getting raw data from the SONO-probe without averaging and filtering.
  Mode CA: (Cyclic-Average-Filter) For relative short measuring processes with continual average value, filtering and an accuracy of up to 0.1%
  Mode CF: (Cyclic-Float-Average) for continual average value with filtering and an accuracy of up to 0.1% for very slowly measuring processes, e.g. in fluidized bed dryers, conveyor belts, etc.
  Mode CK: (Cyclic-Kalman-Filter with Boost) Standard setting for SONO-MIX MINI for use in fresh concrete mixer with continual average value with special dynamic Kalman filtering and an accuracy of up to 0.1%.
  Mode CC: (Cyclic Cumulated) with automatic summation of a moisture quantity during one batch process.
  Mode CH: (Cyclic Hold) similar to Mode CC but without summation. For applications in the construction industry. If the SONO-probe is installed under a silo flap, Mode CH can measure moisture when batch cycles are very short, down to 2 seconds. Mode CH executes an automatic filtering, e.g. if dripping water occurs.

Each of these settings will be preserved after shut down of the probe and is therefore stored on a permanent basis.

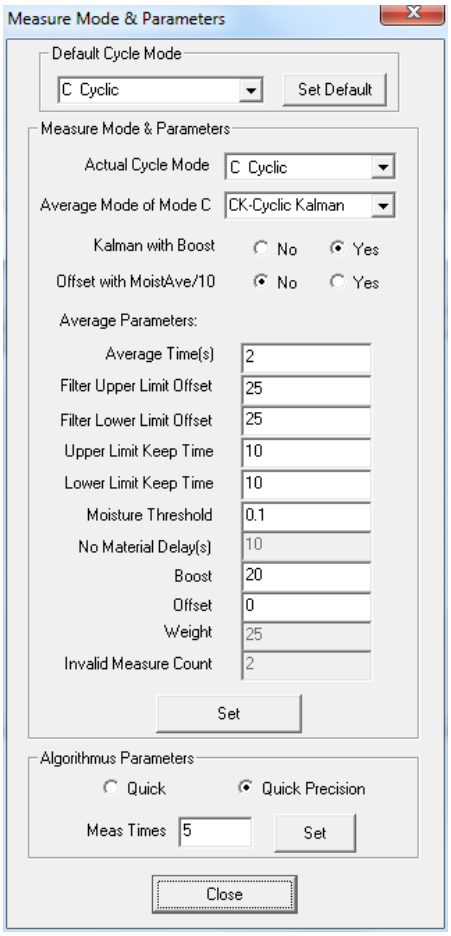
2.1. Operation Mode CA and CF at non-continuous Material Flow

For mode CA and CF the SONO probes are supplied ex-factory with suited parameters for the averaging time and with a universally deployable filter function suited for most currently applications.

The setting options and special functions of SONO probes depicted in this chapter are only rarely required. It is necessary to take into consideration that the modification of the settings or the realisation of these special functions may lead to faulty operation of the probe!

For applications with non-continuous material flow, there is the option to optimise the control of the measurement process via the adjustable filter values *Filter-Lower-Limit, Filter-Upper-Limit* and the time constant *No-Material-Keep-Time*. The continual/floating averaging can be set with the parameter *Average-Time*.

Parameters in the Measurement Mode CA, CF, CC, CH and CK	***Function***
Average-Time Standard Setting: **2** *Setting Range: 1…20*	The time (in seconds) for the generation of the average value can be set with this parameter.
Filter-Upper-Limit-Offset Standard Setting: **20** *Setting Range: 1….20* *With the setting of 20, this parameter must be disabled for Mode CK !*	Too high measurement values generated due to metal wipers or blades are filtered out. The offset value in % is added to the dynamically calculated upper limit.
Filter-Lower-Limit-Offset Standard Setting: **20** *Setting Range: 1…..20* *With the setting of 20, this parameter must be disabled for Mode CK !*	Too low measurement values generated due to insufficient material at the probe head are filtered out. The offset value in % is subtracted from the dynamically calculated lower limit with the negative sign.
Upper-Limit-Keep-Time Standard Setting: **10** *Setting Range: 1...100* *With the setting of 100, this parameter must be disabled for Mode CK !*	The maximum duration (in seconds) of the filter function for Upper-Limit-failures (too high measurement values) can be set with this parameter.
Lower-Limit-Keep-Time Standard Setting: **10** *Setting Range: 1...100* *With the setting of 100, this parameter must be disabled for Mode CK !*	The maximum duration (in seconds) of the filter function for Lower-Limit-failures (too low measurement values) for longer-lasting "material gaps", ie the time in which no material is located on the probe, can be bridged.
Moisture Threshold (in %-moisture) Standard Setting: 1 *Setting Range: 1….20*	The accumulation of moisture values starts above the „Moisture Threshold“ and the analogue signal is output. The accumulation pauses if the moisture level is below the threshold value.
No-Material-Delay (in seconds) Standard Setting: 5 *Setting Range: 1….20*	The accumulation stopps if the moisture value is below the moisture threshold. The SONO probes starts again in a new batch with a new accumulation after the time span of the “No-Material-Delay” is exceeded.
Boost Standard Setting: 35 *Setting Range: 1….100*	Automatic summation stops, if threshold is below „No-Material-Delay“. After expiration of „No-Material-Delay“, the probe is ready to start a new summation in a new batch.
Offset Standard Setting: 0.5 *Setting Range: 0 ….5*	Non-linearities in the process can be compensated. E.g. in fluid bed dryers non-linearities can occur due to changes in the material density during the drying process. “Offset” works together with the parameter “Average-time”.
Weight Standard Setting: 5 *Setting Range: 0 …..5*	Smoothing factor for measured values. This parameter influences the reaction/response time.
Invalid Measure Count Standard Setting: 2 *Setting Range: 0….. 10* *This par-meter is de-activated in mode CK !*	This parameter works only in mode CC or CH ! Number of discarded (poor) measurement values after the start of a new batch, when „No-Material-Delay“ has triggered. The first measurement values, e.g. due to dripping water, will be rejected.



2.1.1. *Average Time* in the measurement mode CA and CF

SONO probes establishes every 200 milliseconds a new single measurement value which is incorporated into the continual averaging and issues the respective average value in this timing cycle at the analogue output. The averaging time therefore accords to the “memory” of the SONO probe. The longer this time is selected, the more inert is the reaction rate, if differently moist material passes the probe. A longer averaging time results in a more stable measurement value. This should in particular be taken into consideration, if the SONO probe is deployed in different applications in order to compensate measurement value variations due to differently moist materials.

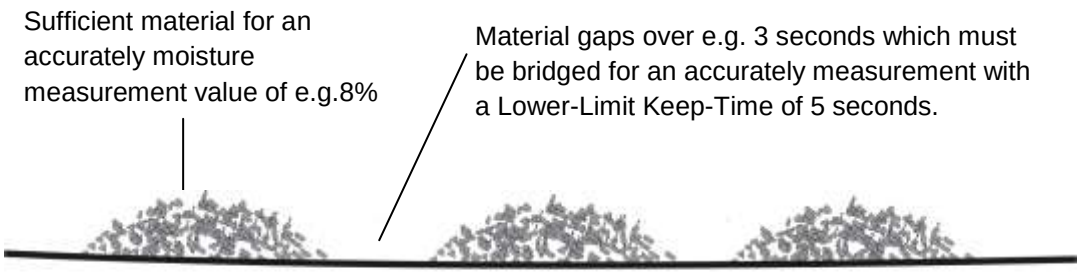
At the point of time of delivery, the *Average Time* is set to 4 seconds. This value has proven itself to be useful for many types of applications. At applications which require a faster reaction rate, a smaller value can be set. Should the display be too “unstable”, it is recommended to select a higher value.

2.1.2. Filtering at material gaps in mode CA and CF

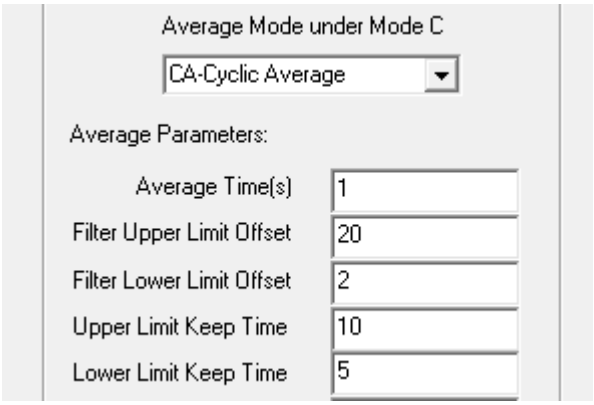
A SONO probe is able to identify, if temporarily no or less material is at the probe head and can filter out such inaccurate measurement values ***(Filter-Lower-Limit)***. Particular attention should be directed at those time periods in which the measurement area of the probe is only partially filled with material for a longer time, i.e. the material (sand) temporarily no longer completely covers the probe head. During these periods (***Lower-Limit-Keep-Time***), the probe would establish a value that is too low. The

Lower-Limit-Keep-Time sets the maximum possible time where the probe could determine inaccurate (too low) measurement values.
Furthermore, the passing or wiping of the probe head with metal blades or wipers can lead to the establishment of too high measurement values (***Filter-Upper-Limit)***. The ***Upper-Limit-Keep-Time*** sets the maximum possible time where the probe would determine inaccurate (too high) measurement values.
Using a complex algorithm, SONO probes are able to filter out such faulty individual measurement values. The standard settings in the **Measurement Mode CA and CF** for the filter functions depicted in the following have proven themselves to be useful for many applications and should only be altered for special applications.

It is appropriate to bridge material gaps in mode CA with Upper- and Lower-Limit Offsets and Keep-Time. For example the Lower-Limit Offset could be adjusted with 2% with a Lower-Limit Keep-Time of 5 seconds. If the SONO probe determines a moisture value which is 2% below the average moisture value with e.g. 8%, than the average moisture value will be frozen at this value during the Lower-Limit Keep-Time of 5 seconds. In this way the material gap can be bridged. This powerful function inside the SONO probe works here as a highpass filter where the higher moisture values are used for building an average value, and the lower or zero values are filtered out. In the following this function is described with SONO parameters.


Sufficient material for an accurately moisture measurement value of e.g.8%
Material gaps over e.g. 3 seconds which must be bridged for an accurately measurement with a Lower-Limit Keep-Time of 5 seconds.

The following parameter setting in mode CA fits a high pass filtering for bridging material gaps.


Average Mode under Mode C
CA-Cyclic Average
Average Parameters:
Average Time(s) 1
Filter Upper Limit Offset 20
Filter Lower Limit Offset 2
Upper Limit Keep Time 10
Lower Limit Keep Time 5

The Filter Upper-Limit is here deactivated with a value of 20, the Filter Lower-Limit is set to 2%. With a Lower-Limit Keep-Time of 5 seconds the average value will be frozen for 5 seconds if a single measurement value is below the limit of 2% of the average value. After 5 seconds the average value is deleted and a new average value building starts. The Keep-Time function stops if a single measurement value lies within the Limit values.

2.2. Overview of single modes for different applications

The following table gives an overview about possible parameter settings in different modes:

Application/ Installation and specific Parameters	**Sand/ Gravel under a silo flap**	**Above a conveyor belt**	**Inside a mixer**	**Inside a fluid bed dryer**	**Gene-rally simple appli-cations**	**in a screw conveyor with filtering options due to metal spiral**	**At the end of a screw conveyor Long term process**
Operating Mode	CH	CH	CK	CK	CA	CK	CF
Average-Time	2	2	5	5	10	10	30
Filter-Upper-Limit Offset	inactiv 100	inactiv 100	inactiv 100	inactiv 100	e.g. 20	inactiv 100	e.g. 20
Filter-Lower-Limit Offset	inactiv 100	inactiv 100	inactiv 100	inactiv 100	e.g. 10	inactiv 100	e.g. 5
Upper-Limit-Keep-Time	inactiv 10	inactiv 10	inactiv 10	inactiv 10	e.g. 10	inactiv 10	e.g. 10
Lower-Limit-Keep-Time	inactiv 10	inactiv 10	inactiv 10	inactiv 10	e.g. 10	inactiv 10	e.g. 10
Moisture Threshold	0.1	0.1	0.1	0.1	-	0.1	-
No-Material-Delay	10	10	10	10	-	inactiv	-
Boost	35	35	20	20	-	20	-
Offset	0.5	0.5	1	1	-	1	-
Weight	5	5	25	25	-	50	-
Invalid Measure Count	2	2	inactiv	inactiv	-	inactiv	-

For very difficult applications, where it is not certain, which mode is the best, we recommend to select **mode CA** with averaging time = 1 second. With help of the software SONO-CONFIG a data record can be stored directly during process conditions. After forwarding this data set to IMKO, we would be pleased to be at your disposal for finding the best suitable working mode.

2.2.1. Calibration of SONO-MIX MINI in a mixing plant

SONO-MIX MINI is delivered with a raw calibration function which is far higher than the real moisture values (kiln dried values) of a sand/gravel or fresh concrete mixture. The reason is that SONO-MIX MINI use a powerful modified Kalman filter algorithm, which would work incorrect at NULL-values (division by zero results in infinite). Therefore it is necessary with SONO-MIX MINI, (as well as with all other moisture probes), to make a recipe specific calibration with the PLC in the mixing plant. Another reason for this calibration is that every mixer type has another behaviour concerning the raw density of the mixed material.
In practice, a mixer moisture probe has to be calibrated with two points in the mixing plant. The first calibration point should be relatively dry, e.g. at 2 to 3% gravimetric moisture. The second point should be in a range which matches the maximum moisture value in practice, e.g. 7%. The closely together these both moisture-values1 and 2 are, the higher could be the measurement error due to the reference measurement, especially at moisture values which are beyond of these two points or not between these two points!
Following process can be recommended:

1. Record the SONO-MIX MINI moisture value at a dry mixture, e.g. **4.5 (probe-value1)**

2. Take a sample of about 2….3kg and determine with kiln drying in the laboratory the correct gravimetric moisture of the sample, e.g. 2.2%. This moisture value can be optionally calculated into liter water per m^3.
   With a raw density of the mixture of e.g. 2.1kg/dm^3 the result could be:
   2.2% * 2.1kg/dm^3 * 10 = 46.2 Liter water per m^3

3. Add an exact amount of water per manual batching into the mixture to achieve the target moisture, e.g add exact 112.0 Liter water per cubic meter of the mixture.

4. Record again with SONO-MIX MINI the second value at the wet mixture, e.g. **8.7 (probe-value2)**

5. Calculation of the moisture value difference of SONO-MIX MINI into the difference of water content in Liter/m^3:

   8.7 (probe-value2) – 4.5 (probe-value1) = 4.2 that means a probe difference of 4.2 corresponds to a water difference of 112.0 liter/m^3 in the mixture.
   This represents:
   112 Liter / 4,2 = 26.67 Liter/m^3 per one point difference of SONO-MIX MINI, or 2.67 Liter/m^3 per 0.1 points difference of SONO-MIX MINI.

2.2.2. Shortest expecting mixing times and density effects at partial loads

Time to evaluate signal at dry mix stage
The sensor can be configured depending on the requirements of the applications, but in the pre-setting it requires 15-20s till the value is stable after filling the mixer with aggregates and cement.

Time to evaluate signal at wet mix stage
The sensor will immediately detect the incoming water, but commonly it lasts a little till the water is distributed homogeneous, thus we suggest not to have shorter wet mixing time than 45s.

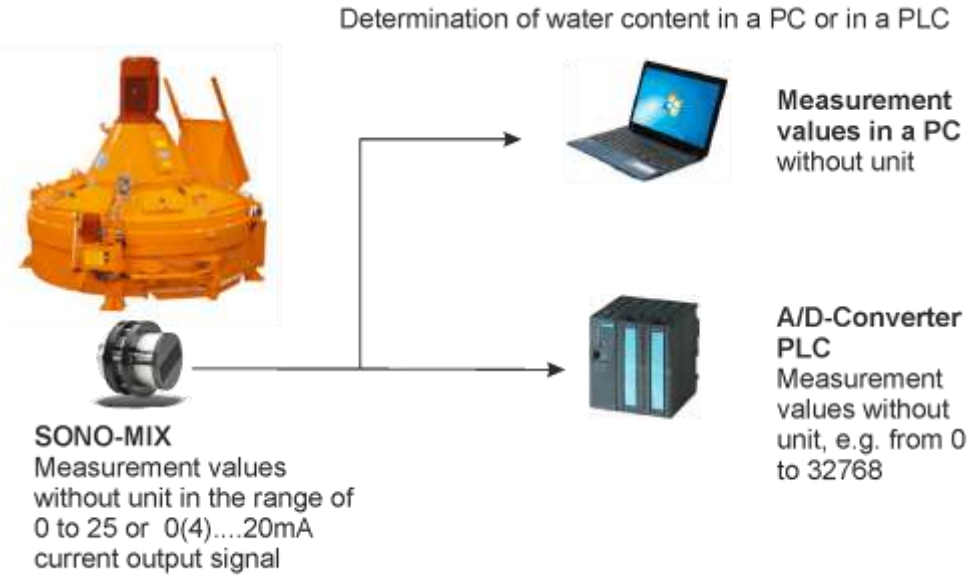
Does density have an effect on accuracy
If the mixer load varies from 20% to 100% of total mixer capacity, it needs to calibrate for different loads. At 20% load, the sensor could experience no material or less material

Different density does always have an effect and on any sensor, operating with an electrical field, but how strong this effect is depends on the installation place in the mixer, as closer to the wall of the mixer, as less this effect is, as due to the mixing energy with smaller batches more material is located at the outside of the mixer.

But it always has to be ensured, that at least one mixing tool cleans the sensor per turn, to ensure the sensor stays clean! Even if close to the wall you will see at least a slight effect of the filling amount.

2.2.3. How to perform a calibration with SONO-MIX MINI for determination of water content, in 3 easy steps

The mixer probe SONO-MIX MINI can measure water content precise, also in wet mixtures with higher cement contents. Therefore it opens up completely new possibilities for the calibration of the SONO-MIX MINI in a mixer control system. In this example we show a new method where kiln drying of concrete samples is not necessary for a calibration of SONO-MIX MINI. Furthermore the creation of different recipes should be easier.
The calculation of water content can be done with a PC or with a PLC. In the following example both options are shown, however only the PLC option is calculated with numbers (A/D-Converter PLC).


Determination of water content in a PC or in a PLC
Measurement values in a PC without unit
A/D-Converter PLC Measurement values without unit, e.g. from 0 to 32768
SONO-MIX Measurement values without unit in the range of 0 to 25 or 0(4)....20mA current output signal

Recommended way:

In this example the SONO-MIX MINI has to be calibrated with a PLC for a concrete recipe with a specification of a setpoint wc-value of 0.385 (water/cement). With a binder content of 180kg the **setpoint for the water content** for the concrete results in **62.1 liter**.

1. Record measurement values in the PLC for the dry mixture, i.e. the mixture has a relative low water content. It is recommended to average the values of the PLC over the last 5 seconds of the dry mixing time. In this example a measurement value of 8126 has been recorded:

	SONO-MIX MINI Measurement values (without unit from 4…20mA current output signal)	Measurement value in a PC (without unit)	**A/D-Converter PLC** (without unit from 0 to max. 32768)	Water content
Measurement values dry mixture	7.968 mA	6.2	8126 This is the **Dry-value-A/D**	? (not yet known)
Measurement values wet mixture				

2. Add water manually into the mixture, e.g. **38 liter mixing water.** Add manually as much water as the concrete recipe has the desired consistency. The added and measured water content is later used for the calculation of the c1-Sensitivity of the SONO-MIX MINI for this recipe.
When the mixture has the optimal consistency, record the measurement values with the PLC in the wet mixture. It is recommended to average the values over the last 5 seconds of the wet mixing time. In this example a measurement value of 14811 has been recorded with the PLC.

	SONO-MIX MINI Measurement values (without unit from 4…20mA current output signal)	Measurement value in a PC (without unit)	**A/D-Converter PLC** (without unit from 0 to max. 32768)	Water content
Measurement values dry mixture	7.968 mA	6.2	8126 This is the **Dry-value-A/D**	After completion of step 2. this value can be calculated in the following way: 62.1 l – 38 l = **24.1 l**
Measurement values wet mixture	11.232mA	11.3	14811 This is the **Target-value-A/D** for this concrete recipe for an optimal consistency of the recipe.	**62.1** (this water content value corresponds to the calculated w/c setpoint for the recipe at the beginning)

Note: For prefab concrete with higher flow spread, it is recommended to record the wet measurement values without concrete plasticizer in the mixture. The reason is that the plasticizer modifies the density of the fresh concrete considerably, which leads to deviations in the measurement values.

3. Determination of the sensitivity of the SONO-MIX MINI for this recipe:
For calibration and calculation of the mixing water for further mixtures, the coefficient c1-Sensitivity of the SONO-MIX MINI can be calculated easily in the following way:

   c1-Sensitivity = (62.1 – 24.1) / (14811 – 8126) = **0.005685**

   With help of the coefficient “c1-Sensitivity”, the amount of mixing water for future mixtures of this recipe can be calculated with the PLC after finishing of the dry mixing times:

   Mixing water = (Target-value-A/D – Dry-value-A/D) * c1 = (14811 – 8126) * 0.005685 = 38 Liter

Because the SONO-MIX MINI measures moisture precise also with different grain size distribution, it is possible to calculate with a standard c1-Sensitivity for similar recipes. For very different recipes, e.g. recipes with colouring agents or other added special materials it is recommended to check the c1-Sensitivity and if necessary determine a new c1-Sensitivity.

For partial quantities you have only to multiply the calculated mixing water value with the partial percentage value, e.g. for an 80% partial quantity multiply 38 liter * 0.8 = 30.4 liter for the mixing water (subject to a correction for partial quantities).

The efforts and expenses for preparation additional parameters for different recipes inside a PLC should be easy and manageable when using this method.

2.2.4. SONO-MIX MINI to control the water/cement ratio

SONO-MIX MINI can be also used to control the w/c-ratio by determination of the moisture respectively the water content at the end of the mixing process. Similar as described in the previous chapter “Calibration …”, a recipe specific calibration with the PLC in the mixing plant can be made at the end of the mixing process with the final fresh concrete. Depending to the concrete recipe the probe has to be calibrated with two points in the mixing plant, however this two points must lie in a closer and higher moisture range, e.g. between 7% to 8% due to the concrete type. With the determined moisture or water content and the known cement content, the w/c-ratio can be calculated. It should be considered, that the PLC should calculate the moisture content with several single values over 3 to 5 seconds shortly before the discharge of the mixture.

2.2.5. Mode CC – automatic summation of a moisture quantity during one batch process

Simple PLCs are often unable to record moisture measurement values during one batch process with averaging and data storage. Furthermore there are applications without a PLC, where accumulated moisture values of one batch process should be displayed for a longer time to the operating staff. Previously available microwave moisture probes on the market show three disadvantages:

1. Such microwave probes need a switching signal from a PLC. This increases the cabling effort.
2. Time delays can occur during the summation time with a trigger signal. This is particularly disadvantageous for small batches. Recipe errors can occur.
3. Material gaps during one batch process will lead to zero measurement values which falsify the accumulated measurement value considerably. Recipe errors can occur.

Unlike current microwave probes, SONO probes work in mode CC with automatic summation, where it is really ensured that material has contact with the probe. This increases the reliability for the moisture measurement during one complete batch process. The summation is only working if material fits at the probe. Due to precise moisture measurement also in the lower moisture range, SONO probes can record, accumulate and store moisture values during a complete batch process without an external switching or trigger signal. The SONO probe “freezes” the analogue signal as long as a new batch process starts. So the PLC has time enough to read in the “freezed” moisture value of the batch. For applications without a PLC the “freezed” signal of the SONO probe can be used for displaying the moisture value to a simple 7-segment unit as long as a new batch process starts.

With the parameter **Moisture Threshold** the SONO probe can be configured to the start moisture level where the summation starts automatically. Due to an automatic recalibration of SONO probes, it is ensured that the zero point will be precisely controlled. The start level could be variably set dependent to the plant. Recommended is a level with e.g. 0.5% to 1%.

With the parameter **No-Material-Delay** a time range can be set, where the SONO probe is again ready to start a new batch process. Are there short material gaps during a batch process which are shorter than the “No-Material-Delay”, with no material at the probes surface, then the SONO probe pauses shortly with the summation. Is the pause greater as the “No-Material-Delay” then the probe is ready to start a new batch process.

How can the mode CC be used, if the SONO probe cannot detect the „moisture threshold“ by itself, e.g. if there is constantly material above the probe over a longer time: In this case, a short interrupt of the probe´s power supply, e.g for about 0.5 seconds with the help of a relay contact of the PLC, can restart the SONO probe at the beginning of the material transport. After this short interrupt the SONO probe starts immediately with the summarizing and averaging.

Please note: It should be noted that no material sticks on the probes surface. Otherwise the moisture zero point of the probe will be shifted up and the probe would not be detect a moisture low value below the “Moisture-Threshold”.

***Following* possible parameter settings in mode CC inside the SONO probe can be set:**

Parameter in mode CC	*Function*
Moisture Threshold (in %-moisture) Standard Setting: 1 *Setting Range: 1….20*	The accumulation of moisture values starts above the „Moisture Threshold“ and the analogue signal is output. The accumulation pauses if the moisture level is below the threshold value.
No-Material-Delay (in seconds) Standard Setting: 5 *Setting Range: 1….20*	The accumulation stopps if the moisture value is below the moisture threshold. The SONO probes starts again in a new batch with a new accumulation after the time span of the “No-Material-Delay” is exceeded.

2.2.6. Mode CC – automatic summation of a moisture quantity during one batch process

Simple PLCs are often unable to record moisture measurement values during one batch process with averaging and data storage. Furthermore there are applications without a PLC, where accumulated moisture values of one batch process should be displayed to the operating staff for a longer time. Previously available microwave moisture probes on the market show three disadvantages:

4. Such microwave probes need a switching signal from a PLC for starting the averaging of the probe. This increases the cabling effort.
5. Time delays can occur during the summation time with a trigger signal which leads to measurement errors. This is particularly disadvantageous for small batches, recipe errors can occur.
6. Material gaps during one batch process will lead to zero measurement values which falsify the accumulated measurement value considerably, recipe errors can occur.

Unlike current microwave probes, SONO probes work in mode CC with automatic summation, where it is really ensured that material has contact with the probe. This increases the reliability for the moisture measurement during one complete batch process. The summation is only working if material fits at the probe. Due to precise moisture measurement also in the lower moisture range, SONO probes can record, accumulate and store moisture values during a complete batch process without an external switching or trigger signal. The SONO probe “freezes” the analogue signal as long as a new batch process starts. So the PLC has time enough to read in the “freezed” moisture value of the batch. For applications without a PLC the “freezed” signal of the SONO probe can be used for displaying the moisture value to a simple 7-segment unit as long as a new batch process starts.

With the parameter **Moisture Threshold** the SONO probe can be configured to the start moisture level where the summation starts automatically. Due to an automatic recalibration of SONO probes, it is ensured that the zero point will be precisely controlled. The start level could be variably set dependent to the plant. Recommended is a level with e.g. 0.5% to 1%.

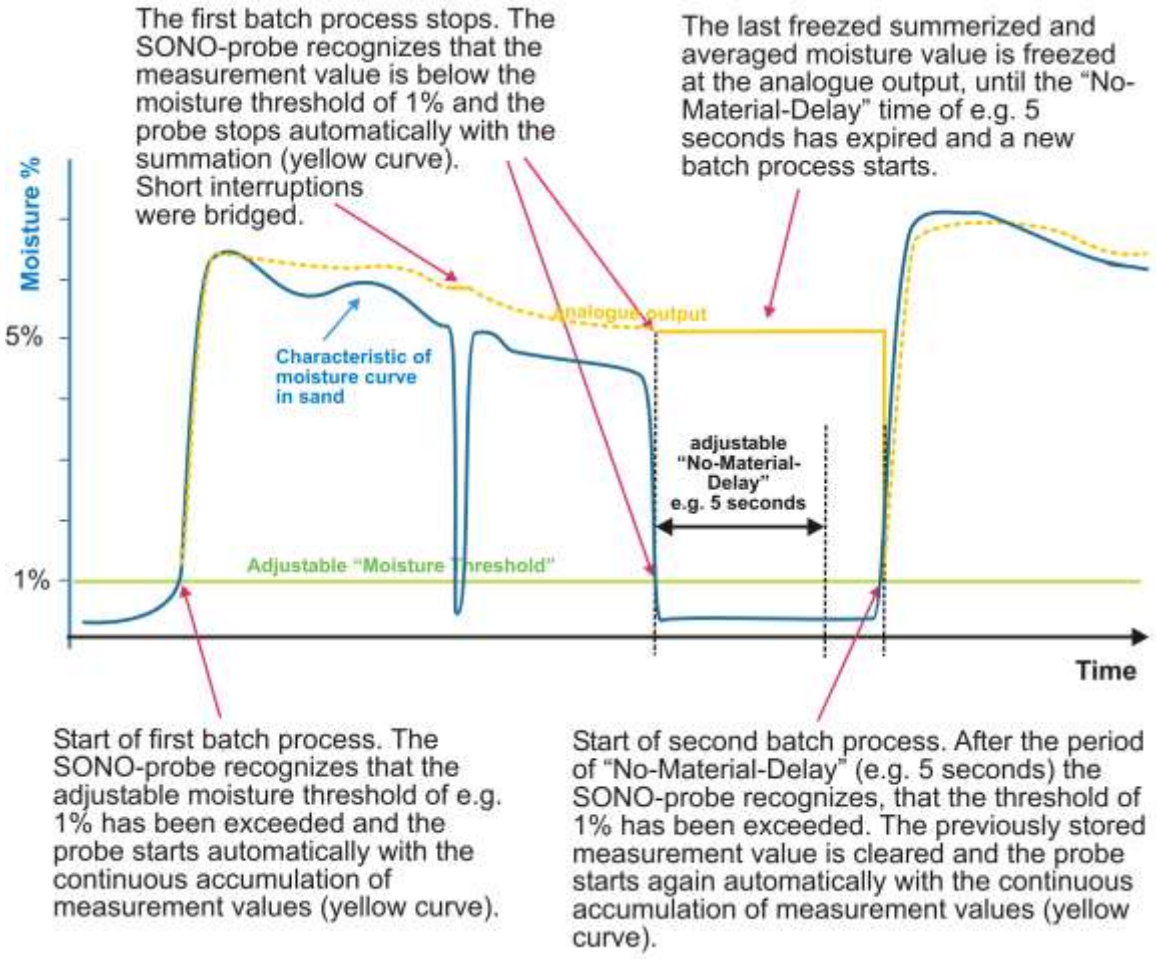
With the parameter **No-Material-Delay** a time range can be set, where the SONO probe is again ready to start a new batch process. Are there short material gaps during a batch process which are shorter than the “No-Material-Delay”, with no material at the probes surface, then the SONO probe pauses shortly with the summation. Is the pause greater as the “No-Material-Delay” then the probe is ready to start a new batch process.

How can the mode CC be used, if the SONO probe cannot detect the „moisture threshold“ by itself, e.g. above a conveyor belt if there is constantly material above the probe over a longer time:

In this case, a short interrupt of the probe´s power supply, e.g for about 0.5 seconds with the help of a relay contact of the PLC, can restart the SONO probe at the beginning of the material transport. After this short interrupt the SONO probe starts immediately with the summarizing and averaging.

Please note: It should be noted that no material sticks on the probes surface. Otherwise the moisture zero point of the probe will be shifted up and the probe would not be detect a moisture low value below the “Moisture-Threshold”.

Time chart for mode CC


The first batch process stops. The SONO-probe recognizes that the measurement value is below the moisture threshold of 1% and the probe stops automatically with the summation (yellow curve). Short interruptions were bridged.
The last freezed summerized and averaged moisture value is freezed at the analogue output, until the “No-Material-Delay” time of e.g. 5 seconds has expired and a new batch process starts.
Moisture %
5%
1%
Analogue output
Characteristic of moisture curve in sand
adjustable “No-Material-Delay” e.g. 5 seconds
Adjustable “Moisture Threshold”
Time
Start of first batch process. The SONO-probe recognizes that the adjustable moisture threshold of e.g. 1% has been exceeded and the probe starts automatically with the continuous accumulation of measurement values (yellow curve).
Start of second batch process. After the period of “No-Material-Delay” (e.g. 5 seconds) the SONO-probe recognizes, that the threshold of 1% has been exceeded. The previously stored measurement value is cleared and the probe starts again automatically with the continuous accumulation of measurement values (yellow curve).

2.2.7. Mode CH – Automatic Moisture Measurement in one Batch

Mode CH (Cyclic Hold) is identically to Mode CC but without summation. If the PLC already accumulates moisture values, than an additional automatic summation of a moisture quantity inside the SONO-probe during one batch process will produce errors.

Mode CH is for applications in the construction industry. If the SONO-probe is installed under a silo flap, Mode CH can measure moisture when batch cycles are very short, down to 2 seconds. Mode CH executes an automatic filtering, e.g. if dripping water occurs.

2.3. Overview of single modes for different applications

The following table gives an overview about possible parameter settings in different modes:

Application/ Installation and specific Parameters	**Sand/ Gravel under a silo flap**	**Above a conveyor belt**	**Inside a mixer**	**Inside a fluid bed dryer**	**Gene-rally simple appli-cations**	**in a screw conveyor with filtering options due to metal spiral**	**At the end of a screw conveyor Long term process**
Operating Mode	CH	CH	CK	CK	CA	CK	CF
Average-Time	2	2	5	5	10	10	30
Filter-Upper-Limit Offset	inactiv 100	inactiv 100	inactiv 100	inactiv 100	e.g. 20	inactiv 100	e.g. 20
Filter-Lower-Limit Offset	inactiv 100	inactiv 100	inactiv 100	inactiv 100	e.g. 10	inactiv 100	e.g. 5
Upper-Limit-Keep-Time	inactiv 10	inactiv 10	inactiv 10	inactiv 10	e.g. 10	inactiv 10	e.g. 10
Lower-Limit-Keep-Time	inactiv 10	inactiv 10	inactiv 10	inactiv 10	e.g. 10	inactiv 10	e.g. 10
Moisture Threshold	0.1	0.1	0.1	0.1	-	0.1	-
No-Material-Delay	10	10	10	10	-	inactiv	-
Boost	35	35	20	20	-	20	-
Offset	0.5	0.5	1	1	-	1	-
Weight	5	5	25	25	-	50	-
Invalid Measure Count	2	2	inactiv	inactiv	-	inactiv	-

For very difficult applications, where it is not certain, which mode is the best, we recommend to select **mode CA** with averaging time = 1 second. With help of the software SONO-CONFIG a data record can be stored directly during process conditions. After forwarding this data set to IMKO, we would be pleased to be at your disposal for finding the best suitable working mode.

3. Calibration Curves

SONO-MIX MINI is supplied with the calibration curve **Cal9 MIX** for the mixer operation with sand and gravel. **Cal9 MIX** is slightly increased in the dry measurement range to ensure that in dry sand and gravel, the readings do not move to 0% values, because values around 0% can be disadvantageous for the filter arithmetic. So in dry sand/gravel the readings of the SONO-MIX MINI show higher measurement values. For an absolute value calculation for the water addition into the mixer it is important to take this into account. In general, the calibration of the probe for the water addition by a PLC has to be determined with laboratory measurement methods (oven drying).

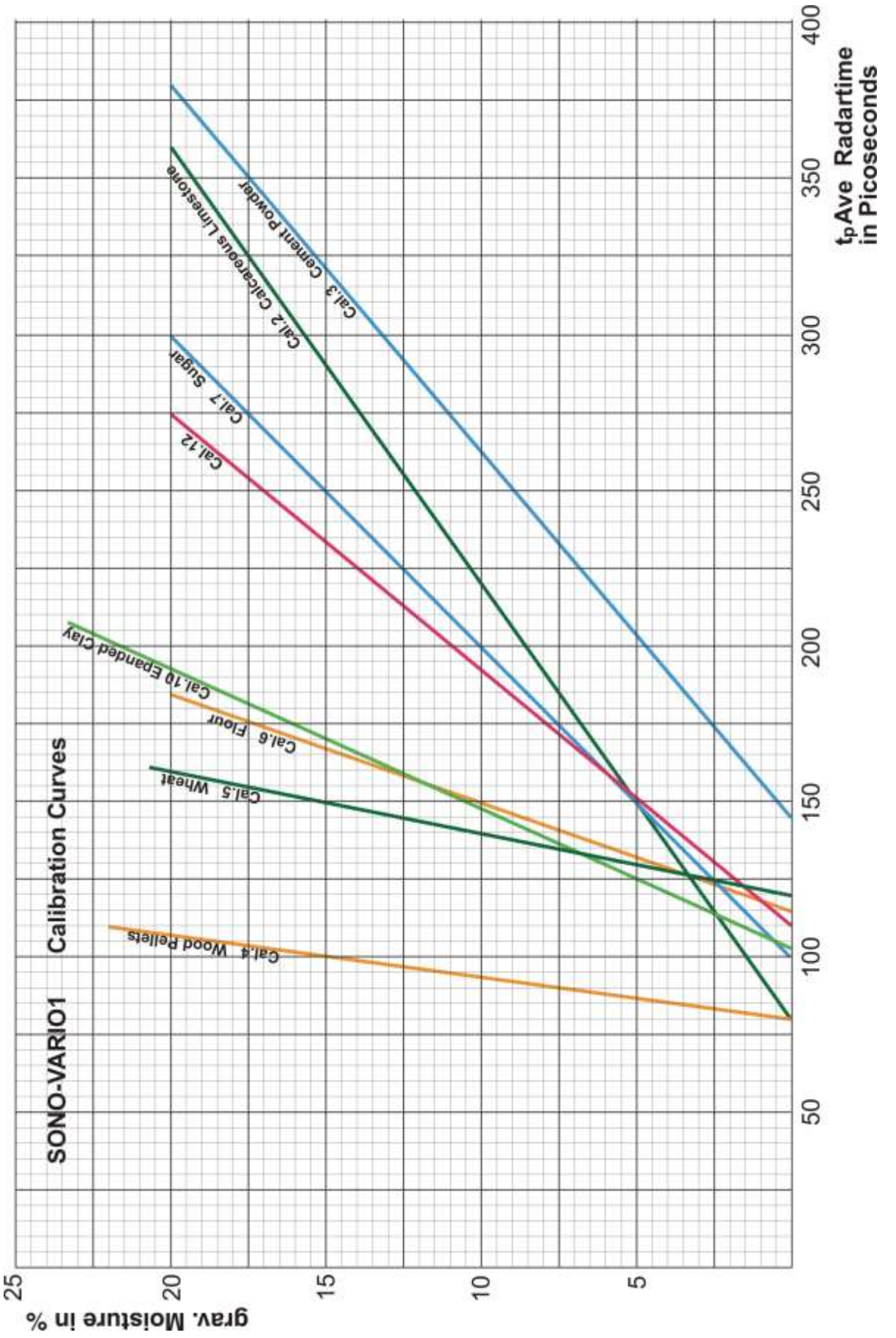
A maximum of 15 different calibration curves (Cal1 ... Cal15) are stored inside the SONO probe and can optionally be activated via the program **SONO-CONFIG**. If SONO-MIX MINI is used without mixer operation, only for measuring the moisture content of aggregates like sand and gravel, then the calibration curve Cal. 1 (Universal Sand Mix) must be set. If SONO-MIX MINI isn´t used inside a mixer but e.g. beneath a flap, the operation mode must be changed from CK to CA.

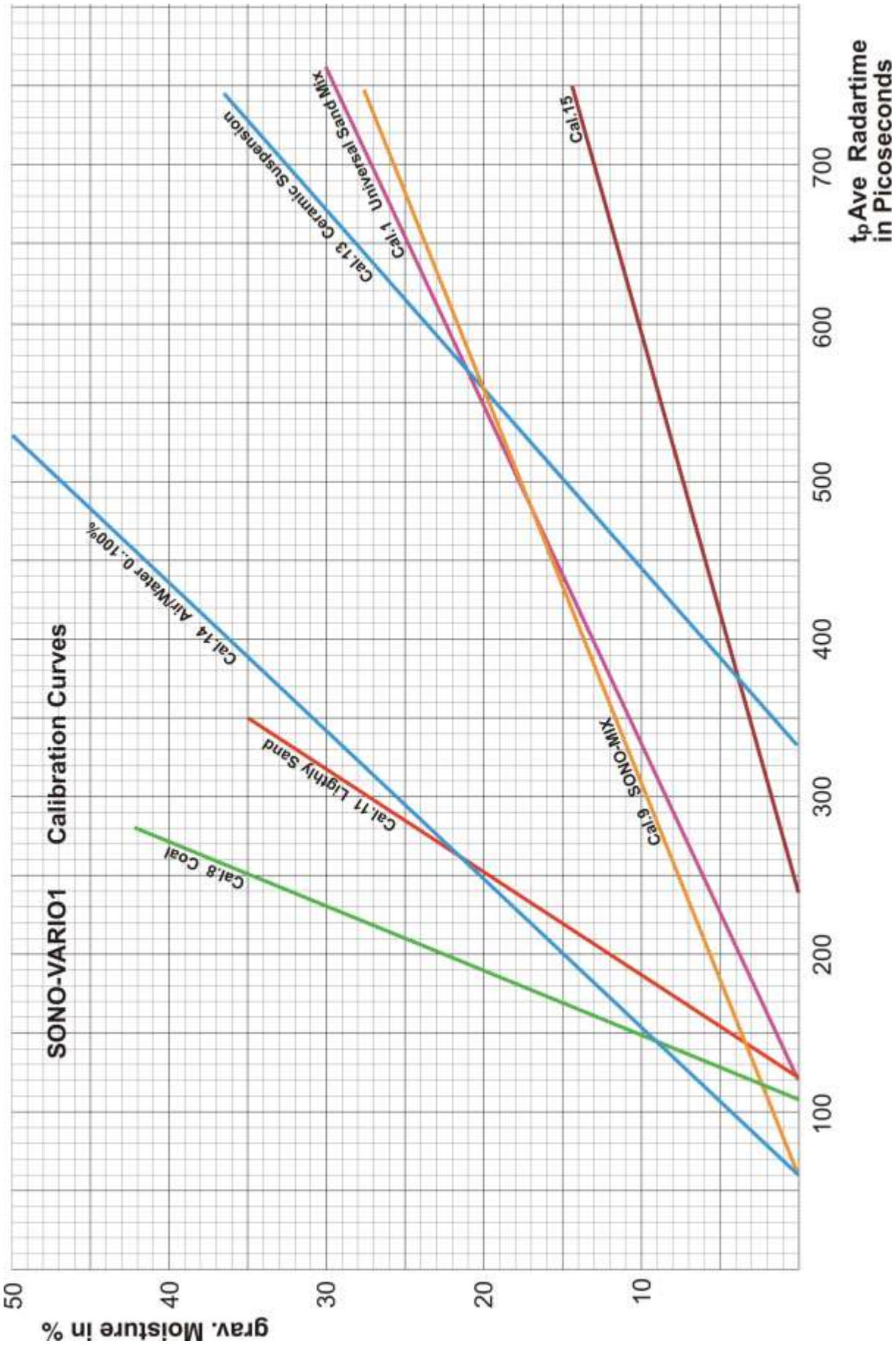
A preliminary test of an appropriate calibration curve (Cal1. .15) can be activated in the menu **"Calibration"** and in the window **“Material Property Calibration"** by selecting the desired calibration curve (Cal1...Cal15) and with using the button “**Set Active Calib**”. The finally desired and possibly altered calibration curve (Cal1. .15) which is activated after switching on the probes power supply will be adjusted with the button "**Set Default Calib**”.

Nonlinear calibrations are possible with polynomials up to 5th grade (coefficients m0 to m5).

IMKO publish on its website more suitable calibration coefficients for different materials. These calibration coefficients can be entered and stored in the SONO probe by hand (Cal14 and Cal15) with the help of SONO-CONFIG.

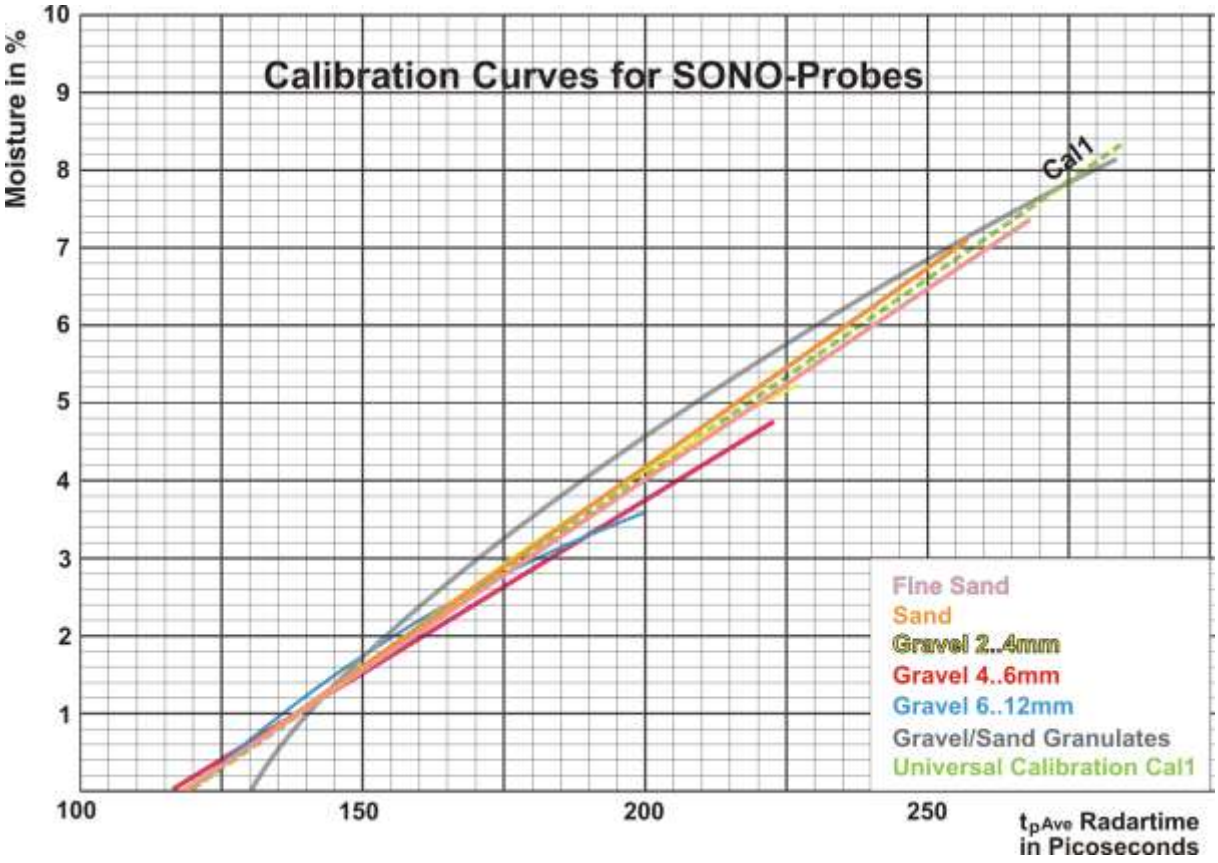
The following charts (Cal.1 .. 15) show different selectable calibration curves which are stored inside the SONO probe.
On the y-axis the gravimetric moisture (**MoistAve**) is shown. On the x-axis depending on the calibration curve the associated radar time **tpAve** in picoseconds is shown. With the software **SONO-CONFIG** the radar time **tpAve** is shown on the screen parallel to the moisture value **MoistAve** (see "Quick Guide for the Software SONO-CONFIG).


SONO-VARIO1 Calibration Curves
grav. Moisture in %
25
20
15
10
5
tpAve Radartime in Picoseconds
400
350
300
250
200
150
100
50
Cal.3 Cement Powder
Cal.2 Calcareous Limestone
Cal.7 Sugar
Cal.12
Cal.10 Expanded Clay
Cal.6 Flour
Cal.5 Wheat
Cal.4 Wood Pellets


SONO-VARIO1 Calibration Curves
grav. Moisture in %
50
40
30
20
10
tp Ave Radartime in Picoseconds
100
200
300
400
500
600
700
Cal.14 Air/Water 0..100%
Cal.13 Ceramic Suspension
Cal.1 Universal Sand Mix
Cal.15
Cal.9 SONO-Mix
Cal.11 Lightly Sand
Cal.8 Coal

3.1.1. SONO-MIX MINI for measuring Moisture of Sand and Aggregates

The TRIME-TDR technology with the radar method offers high reliability for measuring moisture of sand and aggregates, as different grain sizes, unlike other measurement techniques such as microwave technology, do not cause any distortion of the measurement result.
The calibration curve **Cal1 "Universal Sand Mix"** is suitable for measuring the moisture in bulk sand, gravel and gravel/sand granulates. The deviations for the below listed gravel/sand types to the universal calibration curve Cal1 are so low that only one single calibration curve may be used.



Fine Sand

Sand

Gravel 2..4mm

Gravel 4..6mm

Gravel 6..12mm

Gravel/Sand Granulates

3.2. Creating a linear Calibration Curve for a specific Material

The calibration curves Cal1 to Cal15 can be easily created or adapted for specific materials with the help of SONO-CONFIG. Therefore, two measurement points need to be identified with the probe. Point P1 at dried material and point P2 at moist material where the points P1 and P2 should be far enough apart to get a best possible calibration curve. The moisture content of the material at point P1 and P2 can be determined with laboratory measurement methods (oven drying). It is to consider that sufficient material is measured to get a representative value.

Under the menu **"Calibration**" and the window "**Material Property Calibration**" the calibration curves CAL1 to Cal15 which are stored in the SONO probe are loaded and displayed on the screen (takes max. 1 minute). With the mouse pointer individual calibration curves can be tested with the SONO-probe by activating the button "**Set Active Calib**". The measurement of the moisture value (**MoistAve)** with the associated radar time **tpAve** at point P1 and P2 is started using the program SONO-CONFIG in the sub menu "**Test**" and "**Test in Mode CA**" (see "Quick Guide for the Software SONO- CONFIG").

Step 1: The radar pulse time **tpAve** of the probe is measured with dried material. Ideally, this takes place during operation of a mixer/dryer in order to take into account possible density fluctuations of the material. It is recommended to detect multiple measurement values for finding a best average value for **tpAve**. The result is the first calibration point P1 (e.g. 70/0). I.e. 70ps (picoseconds) of the radar pulse time **tpAve** corresponds to 0% moisture content of the material. But it would be also possible to use a higher point P1´ (e.g. 190/7) where a **tpAve** of 190ps corresponds to a moisture content of 7%. The gravimetric moisture content of the material, e.g. 7% has to be determined with laboratory measurement methods (oven drying).

Step 2: The radar pulse time **tpAve** of the probe is measured with moist material. Ideally, this also takes place during operation of a mixer/dryer. Again, it is recommended to detect multiple measurement values of **tpAve** for finding a best average value. The result is the second calibration point P2 with X2/Y2 (e.g. 500/25). I.e. **tpAve** of 500ps corresponds to 25% moisture content. The gravimetric moisture content of the material, e.g. 25% has to be determined with laboratory measurement methods (oven drying).

Step 3: With the two calibration points P1 and P2, the calibration coefficients m0 and m1 can be determined for the specific material (see next page).

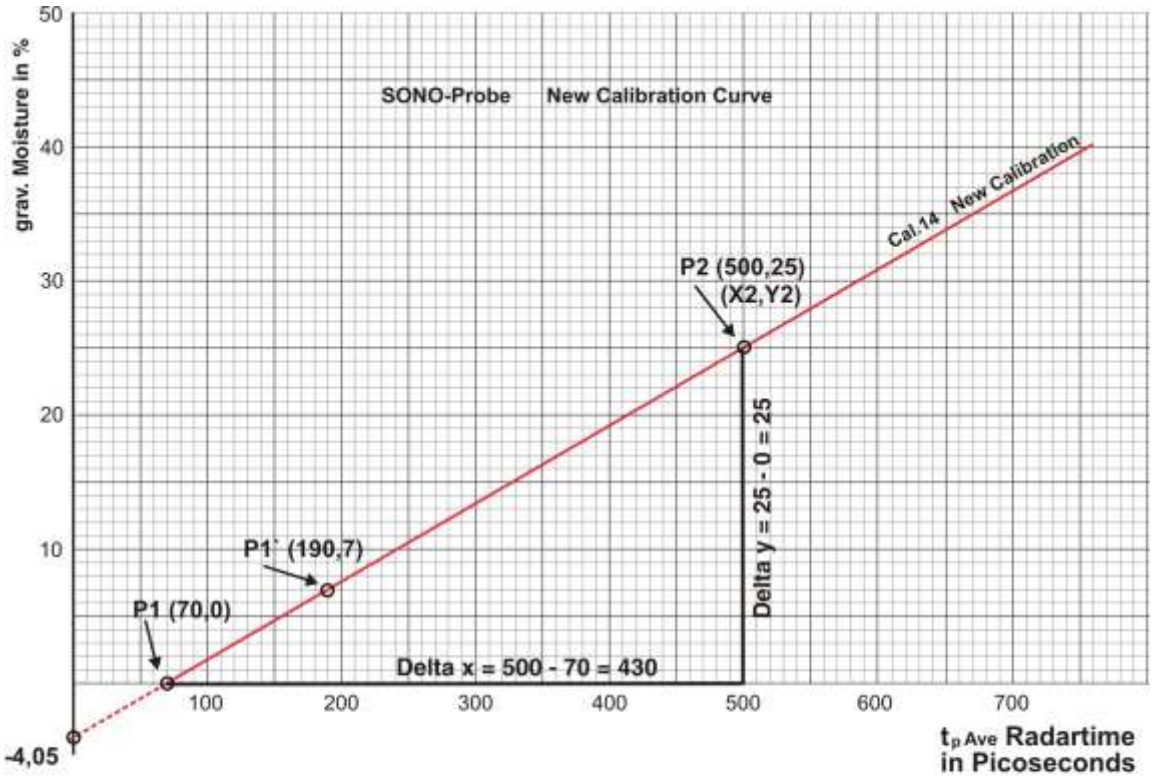
Step 4: The coefficients m1 = 0.0581 and m0 = -4.05 (see next page) for the calibration curve Cal14 can be entered directly by hand and are stored in the probe by pressing the button "**Set**". The name of the calibration curve can also be entered by hand. The selected calibration curve (e.g. Cal14) which is activated after switching on the probes power supply will be adjusted with the button "**Set Default Calib**".

Attention: Use "dot" as separator (0.0581), not comma !

3.2.1. Nonlinear calibration curves

SONO probes can also work with non-linear calibration curves with polynomials up to 5th grade. Therefore it is necessary to calibrate with 4…8 different calibration points. To calculate nonlinear coefficients for polynomials up to 5th grade, an EXCEL software tool from IMKO can be used (on request). It is also possible to use any mathematical program like MATLAB for finding a best possible nonlinear calibration curve with suitable coefficient parameters m0 to m5.

The following diagram shows a sample calculation for a linear calibration curve with the coefficients m0 and m1 for a specific material.



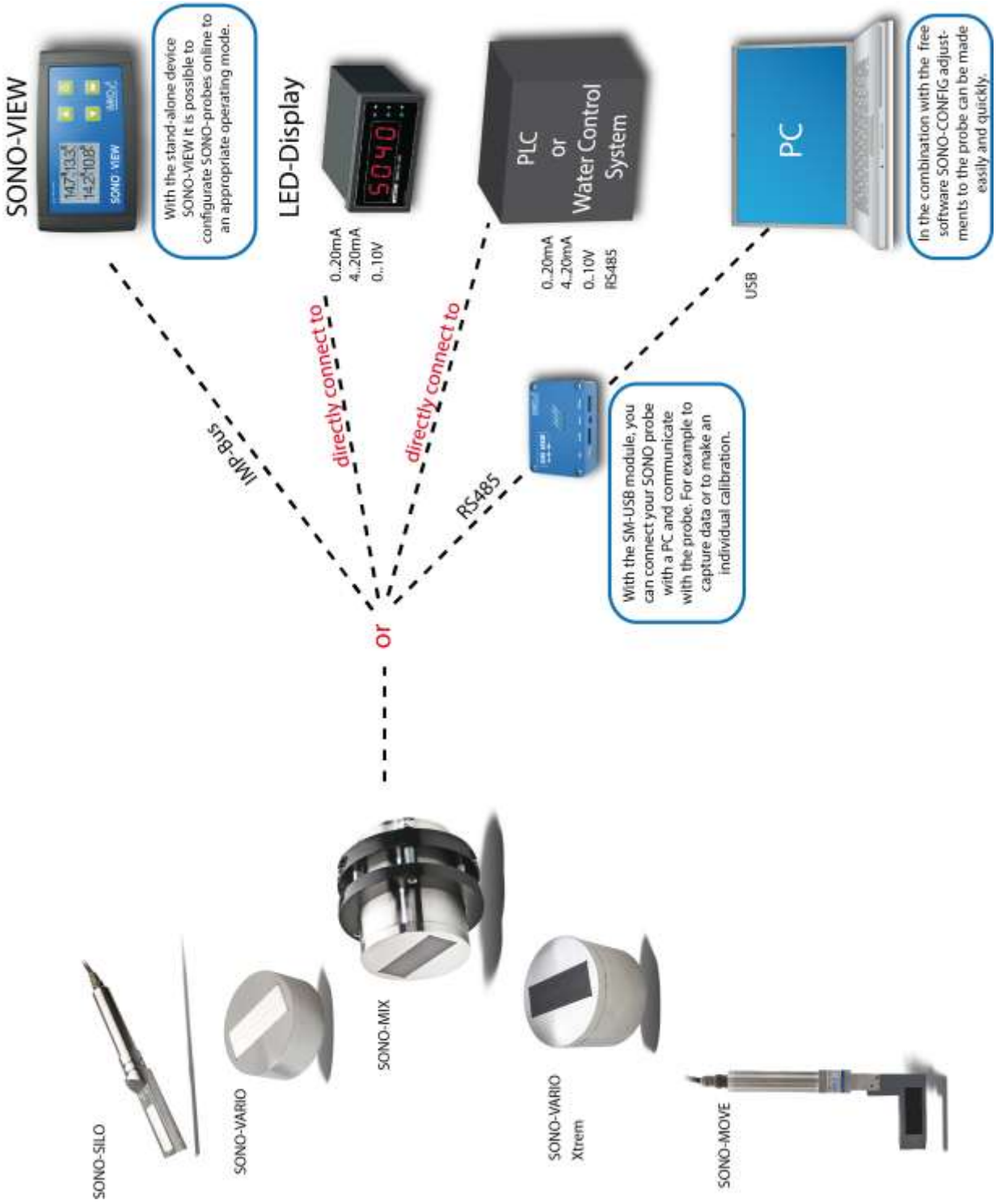
The coefficient m_1 is calculated from the slope of the curve Cal14:

$$\text{Coefficient } m_1 = \frac{\text{Delta y}}{\text{Delta x}} = \frac{25 - 0}{500 - 70} = 0{,}0581$$

The coefficient m_0 is the offset on the y-axis at x = 0:

$$\text{Coefficient } m_0 = Y2 - (m_1 * X2) = 25 - (0{,}0581 * 500) = -4{,}05$$

4. Connectivity to SONO Probes



4.1.1. Connection Plug and Plug Pinning

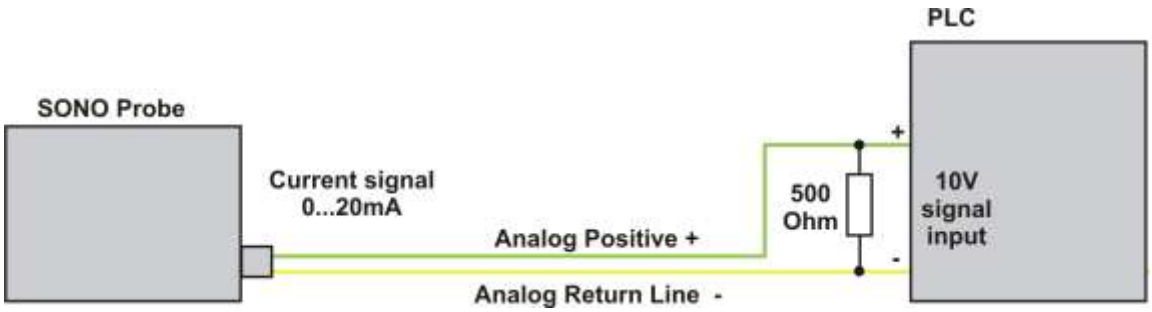
SONO-MIX MINI is supplied with a 10-pole cable with 5 meter length.

Assignment of the 10-pole sensor cable connections:

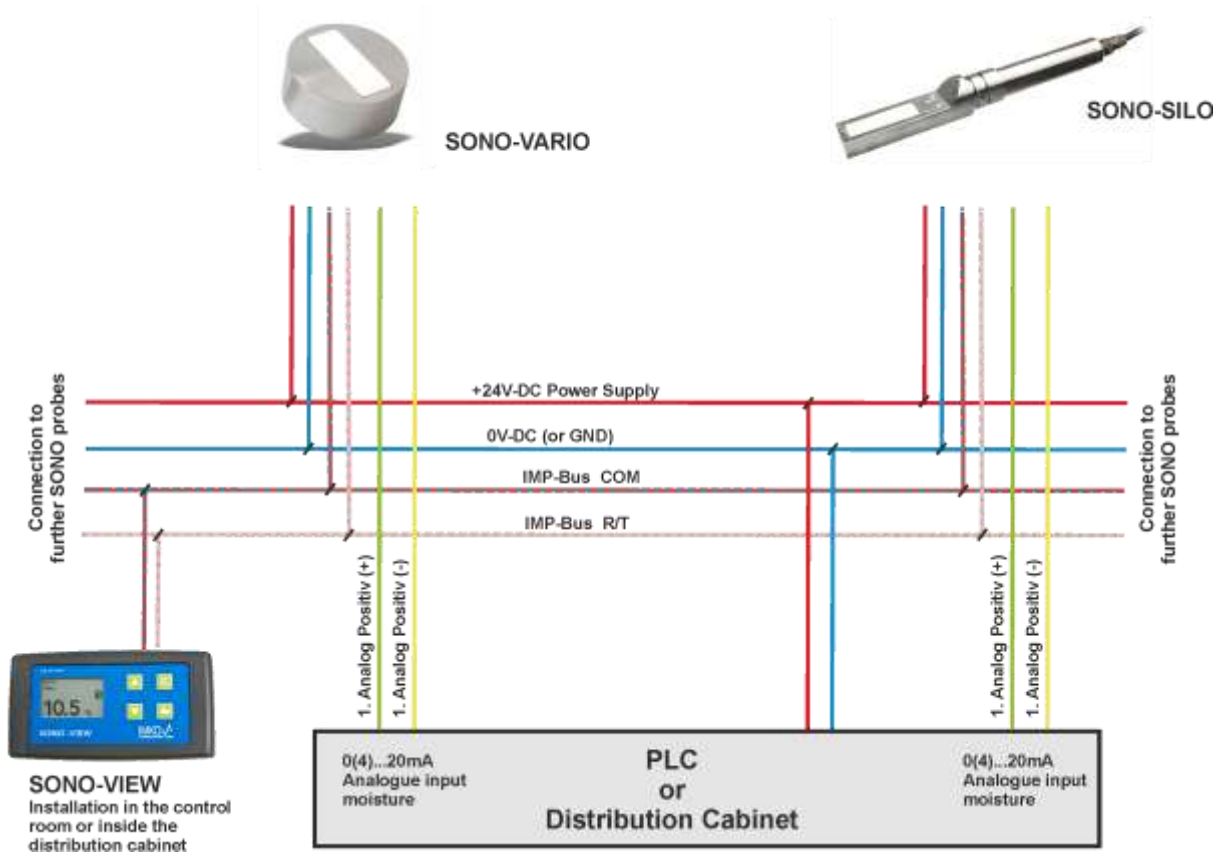
Sensor Connections	Lead Colour	Lead Colour
+7V….24V Power Supply	Weiß	Weiß
0V Power Supply	Braun	Braun
1. Analogue Positive (+) Moisture	Grün	Grün
1. Analogue Return Line (-) Moisture	Gelb	Gelb
RS485 A	n.c.	n.c.
RS485 B	n.c.	n.c.
(rt) IMP-Bus	Rosa	Rosa
(com) IMP-Bus	Grau	Grau
2. Analogue Positive (+)	n.c.	n.c.
2. Analogue Return Line (-)	n.c.	n.c.
Screen (is grounded at the sensor. The plant must be properly grounded!)	n.c.	n.c.

4.1.2. Analogue Output 0..10V with a Shunt-Resistor

There are PLC´s which have no current inputs 0..20mA, but voltage inputs 0..10V. With the help of a shunt resistor with 500 ohm (in the delivery included) it is possible to generate a 0..10V signal from the current signal 0..20mA. The 500 ohm shunt resistor should be placed at the end of the line resp. at the input of the PLC. Following drawing shows the circuit principle.

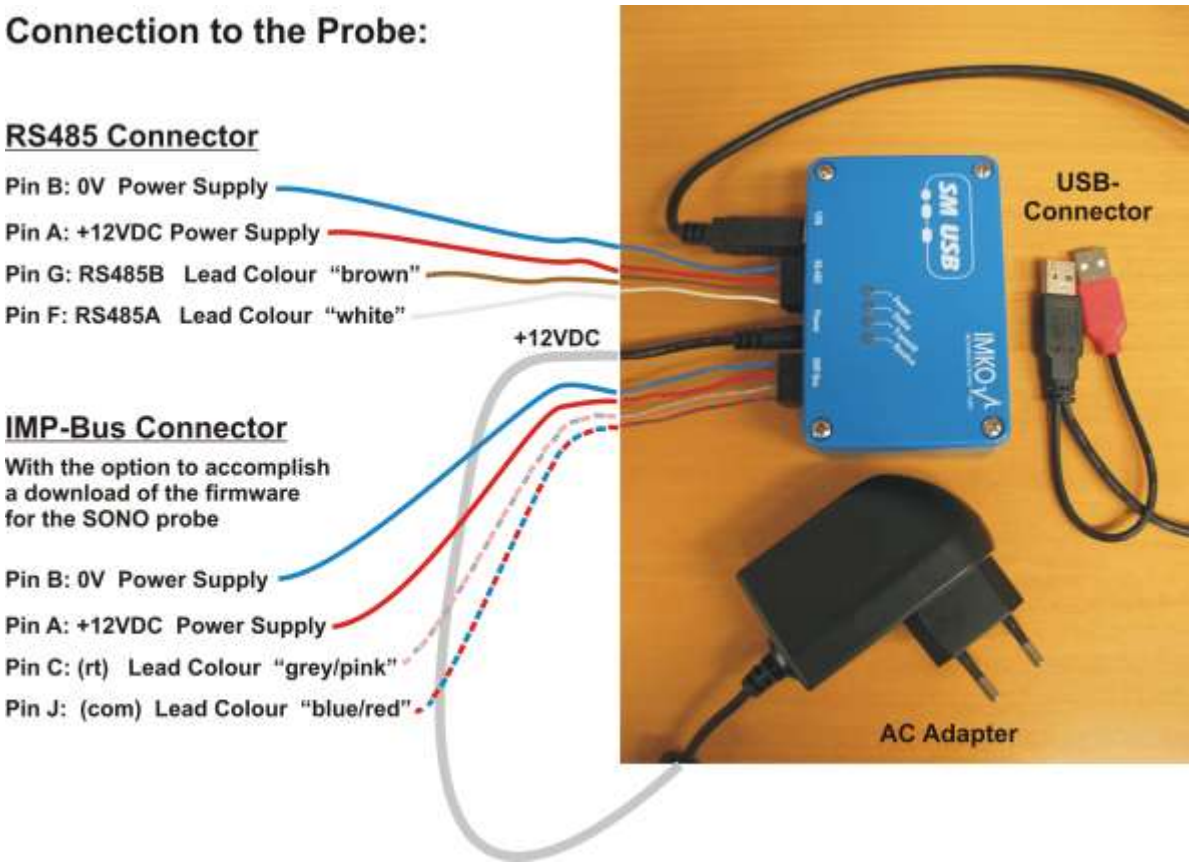


4.1.3. Connection diagram with SONO-VIEW



4.2. Connection of the Probe to the SM-USB Module from IMKO

The SM-USB provides the ability to connect a SONO probe either to the standard RS485 interface or to the IMP-Bus from IMKO. **In fact that the IMP-Bus is more robust and enables the download of a new firmware to the SONO probe, the SONO probes are presetted ex-factory to the IMP-Bus. So it is recommended to use the IMP-Bus for a serial communication**. Both connector ports are shown in the drawing below.
The SM-USB is signalling the status of power supply and the transmission signals with 4 LED´s. When using a dual-USB connector on the PC, it is possible to use the power supply for the SONO probe directly from the USB port of the PC without the use of the external AC adapter.


Connection to the Probe:
RS485 Connector
Pin B: 0V Power Supply
Pin A: +12VDC Power Supply
Pin G: RS485B Lead Colour "brown"
Pin F: RS485A Lead Colour "white"
+12VDC
IMP-Bus Connector
With the option to accomplish a download of the firmware for the SONO probe
Pin B: 0V Power Supply
Pin A: +12VDC Power Supply
Pin C: (rt) Lead Colour "grey/pink"
Pin J: (com) Lead Colour "blue/red"
USB-Connector
SM USB
IMKO
AC Adapter

How to start with the USB-Module SM-USB from IMKO

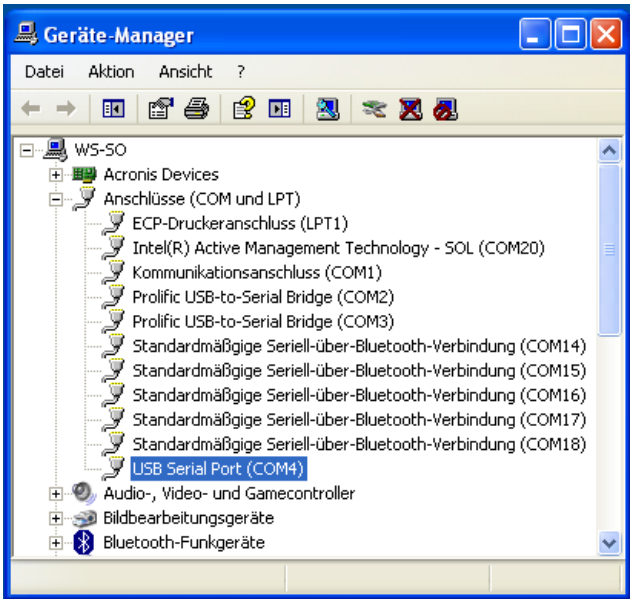
- Install USB-Driver from USB-Stick.
- Connect the SM-USB to the USB-Port of the PC and the installation will be accomplished automatically.
- Install Software **SONOConfig-SetUp.msi** from USB-Stick.
- Connection of the SONO probe to the SM-USB via the serial interface and power supply.
- Check the setting of the COM-Ports in the Device-Manager und setup the specific COM-Port with the Baudrate of 9600 Baud in SONO-CONFIG with the button "**Bus**" and "**Configuration**" (COM1-COM15 is possible).
- Start "**Scan probes**" in SONOConfig.
- The SONO probe logs in the window „**Probe List**" after max. 30 seconds with its serial number.

Note 1:

In the Device-Manager passes it as follows:

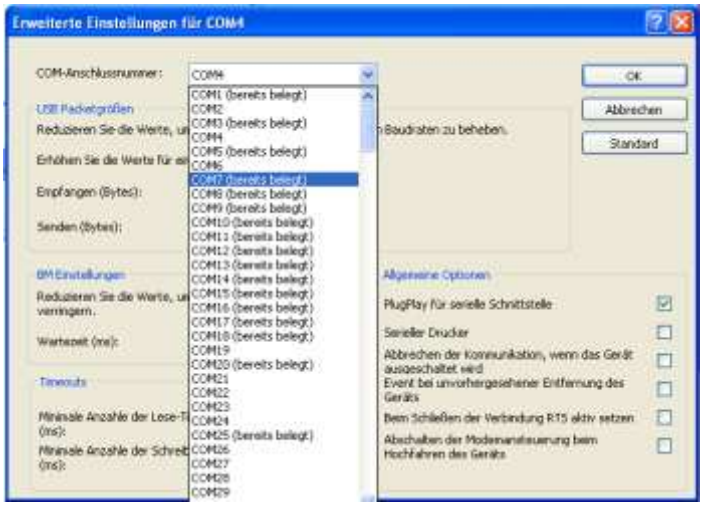
Control Panel → System → Hardware → Device-Manager

Under the entry “Ports (COM & LPT) now the item “USB Serial Port (COMx)” is found.



COMx set must be between COM1….COM9 and it should be ensured that there is no double occupancy of the interfaces.

If it comes to conflicts among the serial port or the USB-SM has been found in a higher COM-port, the COM port number can be adjusted manually:
By double clicking on "USB Serial Port" you can go into the properties menu, where you see "connection settings" – with "Advanced" button, the COM port number can be switched to a free number.

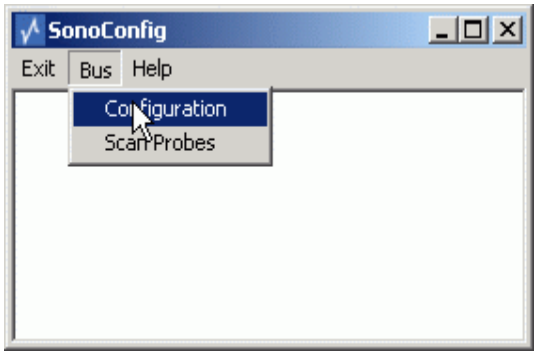


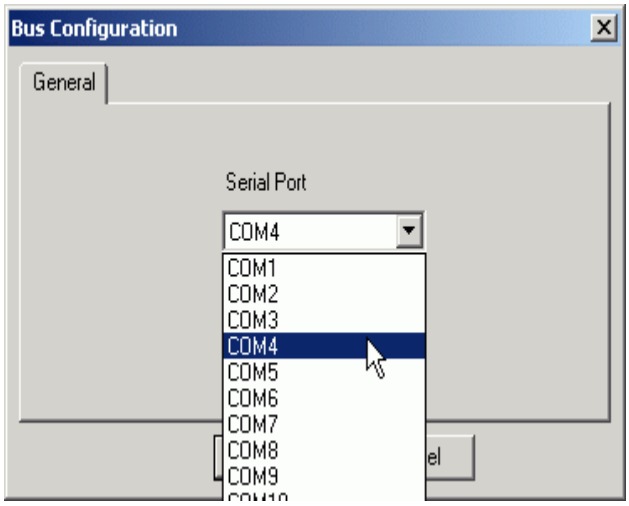
After changing the COMx port settings, SONO-CONFIG must be restarted.

5. Quick Guide for the Commissioning Software SONO-CONFIG

With SONO-CONFIG it is possible to make process-related adjustments of individual parameters of the SONO probe. Furthermore the measurement values of the SONO probe can be read from the probe via the serial interface and displayed on the screen.

In the menu **"Bus**" and the window "**Configuration**" the PC can be configured to an available COMx-port with the Baudrate of 9600 Baud.

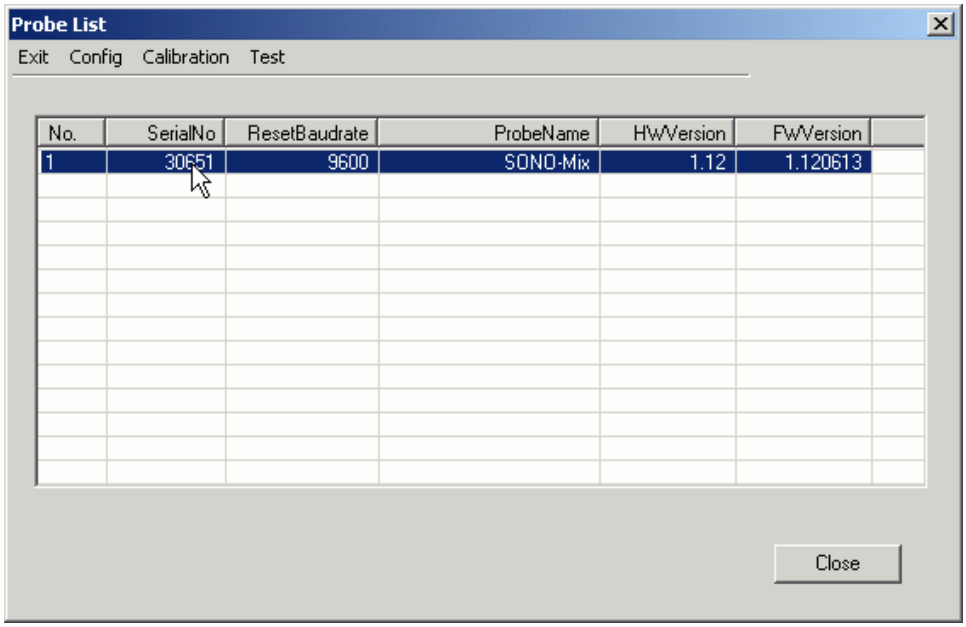




5.1.1. Scan of connected SONO probes on the serial interface

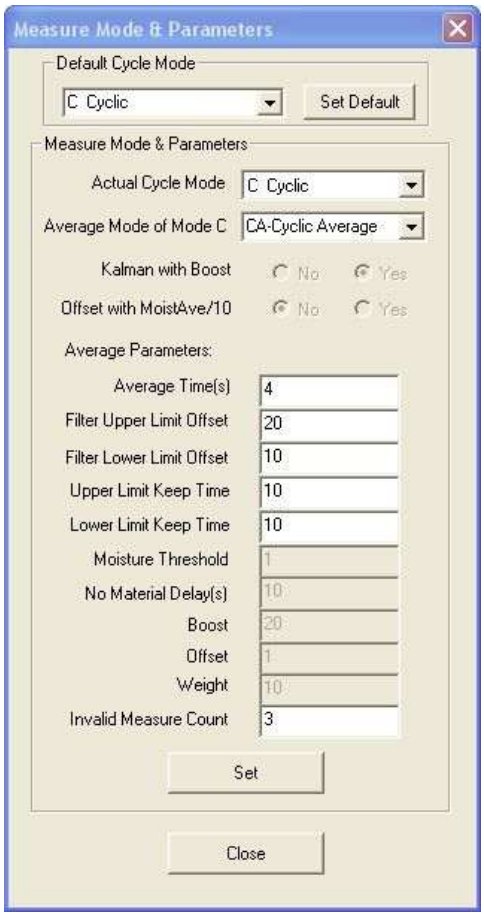
In the menu **"Bus**" and the window "**Scan Probes**" the serial bus can be scanned for attached SONO probes (takes max. 30 seconds).

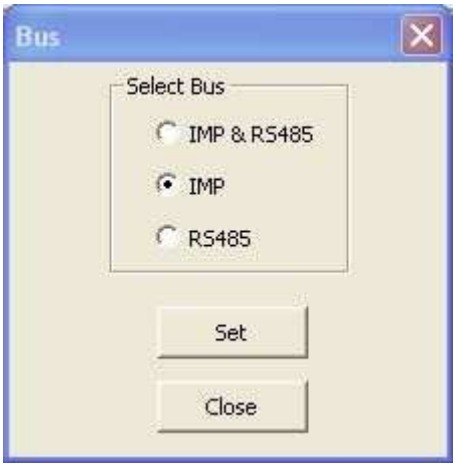
SONO-CONFIG reports one or more connected and founded SONO probes with its serial number in the window "**Probe List**". One SONO probe can be selected by klicking.



5.1.2. Configuration of Measure Mode and serial SONO-interface

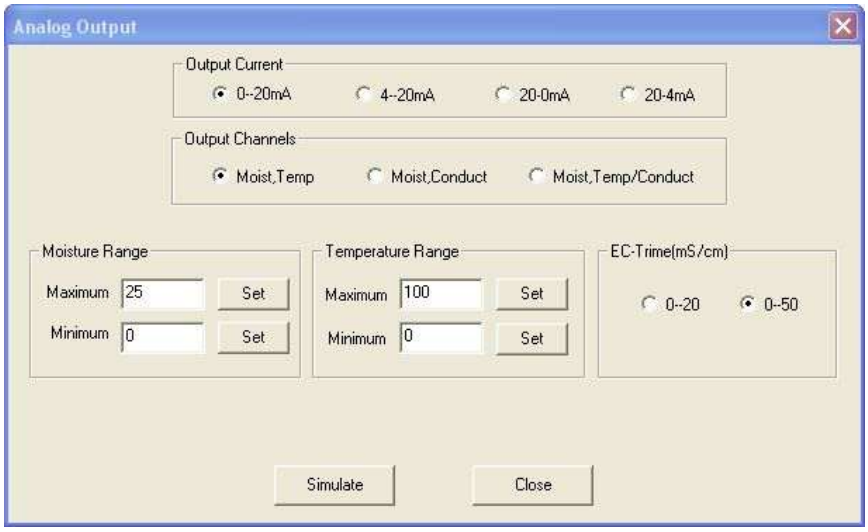
In "**Probe List**" with "**Config**" and "**Measure Mode & Parameters**" the SONO probe can be adjusted to the desired measure mode CA, CF, CS, CK, CC or CH (see Chapter "Configuration Measure Mode"). Furthermore the serial interface inside the SONO probe can be selected to IMP-Bus, RS485 or both interfaces. Due to very robust behavior it is recommended to select the IMP-Bus.





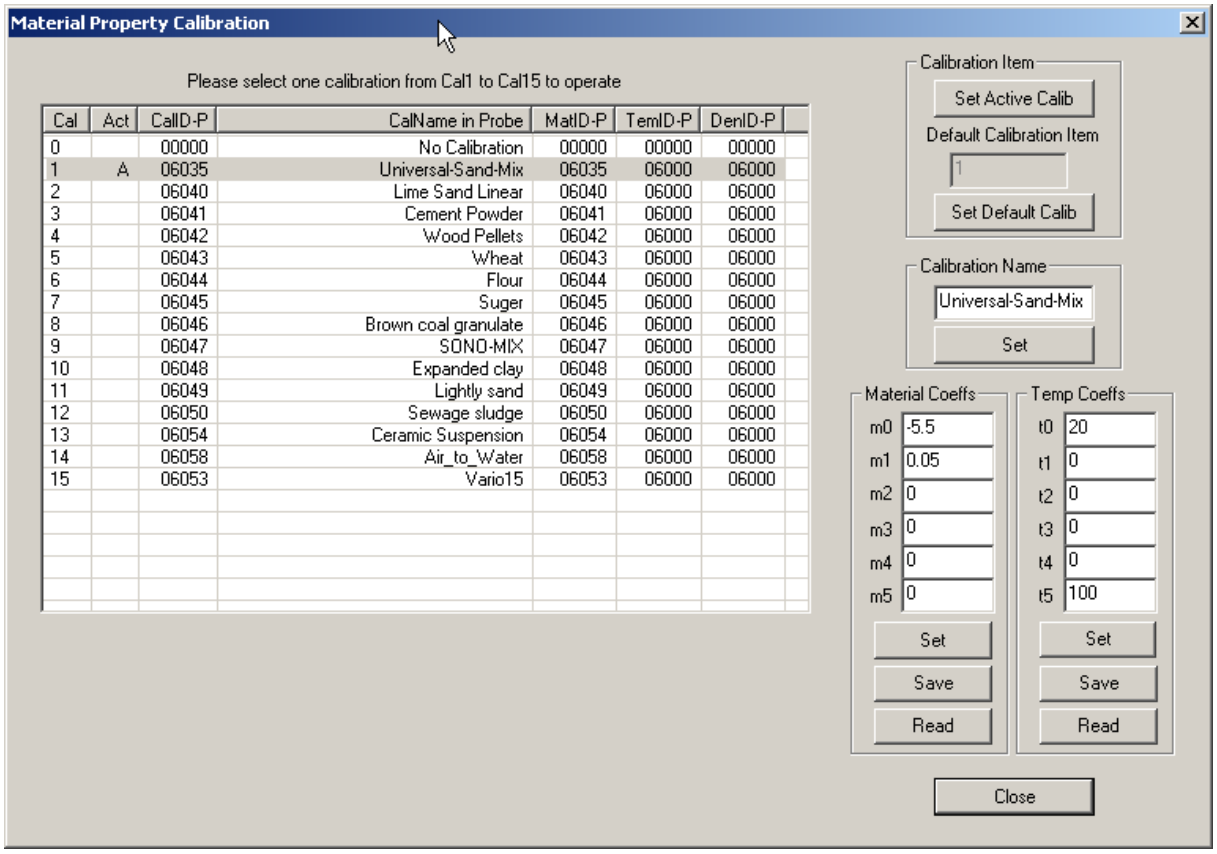
5.1.3. Analogue outputs of the SONO probe

In the menu "**Config**" and the window "**Analog Output**" the analogue outputs of the SONO probe can be configured (see Chapter "Analogue outputs..").



5.1.4. Selection of the individual Calibration Curves

In the menu **"Calibration**" and the window "**Material Property Calibration**" the calibration curves CAL1 to Cal15 which are stored in the SONO probe are loaded and displayed on the screen (takes max. 1 minute). With the mouse pointer individual calibration curves can be activated and tested with the SONO-probe by activating the button "**Set Active Calib**". Furthermore, the individual calibration curves CAL1 to Cal15 can be adapted or modified with the calibration coefficients (see Chapter “Creating a linear calibration curve”).


Material Property Calibration
Please select one calibration from Cal1 to Cal15 to operate
Cal | Act | CalID-P | CalName in Probe | MatID-P | TemID-P | DenID-P
0 | | 00000 | No Calibration | 00000 | 00000 | 00000
1 | A | 06035 | Universal-Sand-Mix | 06035 | 06000 | 06000
2 | | 06040 | Lime Sand Linear | 06040 | 06000 | 06000
3 | | 06041 | Cement Powder | 06041 | 06000 | 06000
4 | | 06042 | Wood Pellets | 06042 | 06000 | 06000
5 | | 06043 | Wheat | 06043 | 06000 | 06000
6 | | 06044 | Flour | 06044 | 06000 | 06000
7 | | 06045 | Suger | 06045 | 06000 | 06000
8 | | 06046 | Brown coal granulate | 06046 | 06000 | 06000
9 | | 06047 | SONO-MIX | 06047 | 06000 | 06000
10 | | 06048 | Expanded clay | 06048 | 06000 | 06000
11 | | 06049 | Lightly sand | 06049 | 06000 | 06000
12 | | 06050 | Sewage sludge | 06050 | 06000 | 06000
13 | | 06054 | Ceramic Suspension | 06054 | 06000 | 06000
14 | | 06058 | Air_to_Water | 06058 | 06000 | 06000
15 | | 06053 | Vario15 | 06053 | 06000 | 06000
Calibration Item
Set Active Calib
Default Calibration Item
1
Set Default Calib
Calibration Name
Universal-Sand-Mix
Set
Material Coeffs
m0 -5.5
m1 0.05
m2 0
m3 0
m4 0
m5 0
Set
Save
Read
Temp Coeffs
t0 20
t1 0
t2 0
t3 0
t4 0
t5 100
Set
Save
Read
Close

The desired and possibly altered calibration curve (Cal1. .15) which is activated after switching on the probes power supply can be adjusted with the button "**Set Default Calib**”.

The calibration name can be entered in the window “Calibration Name”.

The coefficients m0 to m1 (for linear curves) and m0 to m5 (for non-linear curves) can be entered and adjusted directly by hand with the buttons “**Set**” and “**Save**”.

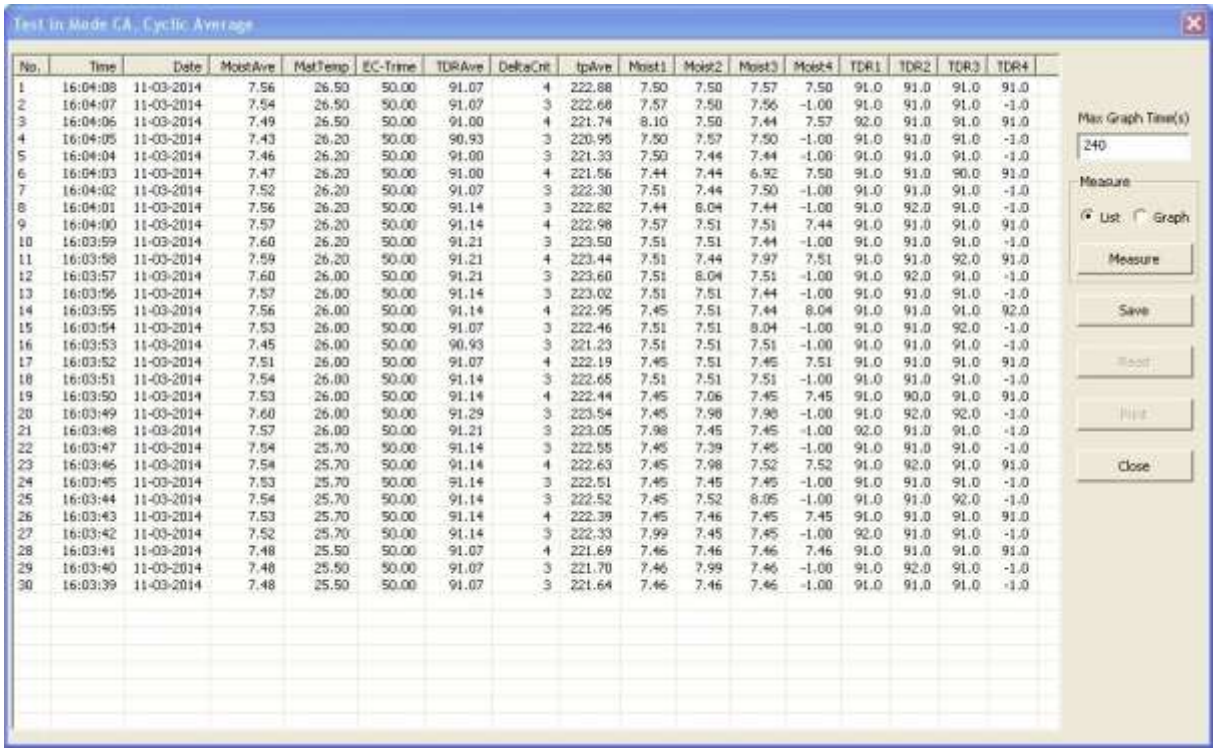
Possible are non-linear calibration curves with polynomials up to fifth order (m0-m5).

Attention: Use “dot” as separator for m0 to m5 not comma !

5.1.5. “Test” run in the respective Measurement Mode

In the menu "**Test**" and the window "**Test in Mode CA or CF**" the measured moisture values **“MoistAve”** (Average) of the SONO probe are displayed on the screen and can be parallel saved in a file. In the menu "**Test**" and the window "**Test in Mode CS**" the measured single measurement values “**Moist**” (5 values per second) of the SONO probe are displayed on the screen and parallel stored in a file. In „**Test in Mode A“** single measurement values (without average) are displayed on the screen and can also be stored in a file.

Attention: for a test run in mode CA, CF, CS or A it must be ensured that the SONO probe was also set to this mode (Measure Mode CA, CF, CS, A). If this is not assured, the probe returns zero values.



No.	Time	Date	MoistAve	MatTemp	EC-Trime	TDRAve	DeltaCnt	tpAve	Moist1	Moist2	Moist3	Moist4	TDR1	TDR2	TDR3	TDR4
1	16:04:08	11-03-2014	7.56	26.50	50.00	91.07	4	222.88	7.50	7.50	7.57	7.50	91.0	91.0	91.0	91.0
2	16:04:07	11-03-2014	7.54	26.50	50.00	91.07	3	222.68	7.57	7.50	7.56	-1.00	91.0	91.0	91.0	-1.0
3	16:04:06	11-03-2014	7.49	26.50	50.00	91.00	4	221.74	8.10	7.50	7.44	7.57	92.0	91.0	91.0	91.0
4	16:04:05	11-03-2014	7.43	26.20	50.00	90.93	3	220.95	7.50	7.57	7.50	-1.00	91.0	91.0	91.0	-1.0
5	16:04:04	11-03-2014	7.46	26.20	50.00	91.00	3	221.33	7.50	7.44	7.44	-1.00	91.0	91.0	91.0	-1.0
6	16:04:03	11-03-2014	7.47	26.20	50.00	91.00	4	221.56	7.44	7.44	6.92	7.50	91.0	91.0	90.0	91.0
7	16:04:02	11-03-2014	7.52	26.20	50.00	91.07	3	222.30	7.51	7.44	7.50	-1.00	91.0	91.0	91.0	-1.0
8	16:04:01	11-03-2014	7.56	26.20	50.00	91.14	3	222.82	7.44	8.04	7.44	-1.00	91.0	92.0	91.0	-1.0
9	16:04:00	11-03-2014	7.57	26.20	50.00	91.14	4	222.98	7.57	7.51	7.51	7.44	91.0	91.0	91.0	91.0
10	16:03:59	11-03-2014	7.60	26.20	50.00	91.21	3	223.50	7.51	7.51	7.44	-1.00	91.0	91.0	91.0	-1.0
11	16:03:58	11-03-2014	7.59	26.20	50.00	91.21	4	223.44	7.51	7.44	7.97	7.51	91.0	91.0	92.0	91.0
12	16:03:57	11-03-2014	7.60	26.00	50.00	91.21	3	223.60	7.51	8.04	7.51	-1.00	91.0	92.0	91.0	-1.0
13	16:03:56	11-03-2014	7.57	26.00	50.00	91.14	3	223.02	7.51	7.51	7.44	-1.00	91.0	91.0	91.0	-1.0
14	16:03:55	11-03-2014	7.56	26.00	50.00	91.14	4	222.95	7.45	7.51	7.44	8.04	91.0	91.0	91.0	92.0
15	16:03:54	11-03-2014	7.53	26.00	50.00	91.07	3	222.46	7.51	7.51	8.04	-1.00	91.0	91.0	92.0	-1.0
16	16:03:53	11-03-2014	7.45	26.00	50.00	90.93	3	221.23	7.51	7.51	7.51	-1.00	91.0	91.0	91.0	-1.0
17	16:03:52	11-03-2014	7.51	26.00	50.00	91.07	4	222.19	7.45	7.51	7.45	7.51	91.0	91.0	91.0	91.0
18	16:03:51	11-03-2014	7.54	26.00	50.00	91.14	3	222.65	7.51	7.51	7.51	-1.00	91.0	91.0	91.0	-1.0
19	16:03:50	11-03-2014	7.53	26.00	50.00	91.14	4	222.44	7.45	7.06	7.45	7.45	91.0	90.0	91.0	91.0
20	16:03:49	11-03-2014	7.60	26.00	50.00	91.29	3	223.54	7.45	7.98	7.98	-1.00	91.0	92.0	92.0	-1.0
21	16:03:48	11-03-2014	7.57	26.00	50.00	91.21	3	223.05	7.98	7.45	7.45	-1.00	92.0	91.0	91.0	-1.0
22	16:03:47	11-03-2014	7.54	25.70	50.00	91.14	3	222.55	7.45	7.39	7.45	-1.00	91.0	91.0	91.0	-1.0
23	16:03:46	11-03-2014	7.54	25.70	50.00	91.14	4	222.63	7.45	7.98	7.52	7.52	91.0	92.0	91.0	91.0
24	16:03:45	11-03-2014	7.53	25.70	50.00	91.14	3	222.51	7.45	7.45	7.45	-1.00	91.0	91.0	91.0	-1.0
25	16:03:44	11-03-2014	7.54	25.70	50.00	91.14	3	222.52	7.45	7.52	8.05	-1.00	91.0	91.0	92.0	-1.0
26	16:03:43	11-03-2014	7.53	25.70	50.00	91.14	4	222.39	7.45	7.46	7.45	7.45	91.0	91.0	91.0	91.0
27	16:03:42	11-03-2014	7.52	25.70	50.00	91.14	3	222.33	7.99	7.45	7.45	-1.00	92.0	91.0	91.0	-1.0
28	16:03:41	11-03-2014	7.48	25.50	50.00	91.07	4	221.69	7.46	7.46	7.46	7.46	91.0	91.0	91.0	91.0
29	16:03:40	11-03-2014	7.48	25.50	50.00	91.07	3	221.70	7.46	7.99	7.46	-1.00	91.0	92.0	91.0	-1.0
30	16:03:39	11-03-2014	7.48	25.50	50.00	91.07	3	221.64	7.46	7.46	7.46	-1.00	91.0	91.0	91.0	-1.0

Following measurement values are displayed on the screen:

MoistAve	Moisture Value in % (Average)
MatTemp	Temperature
EC-TRIME	Radar-based-Conductivity EC-TRIME in dS/m (or mS/cm)
TDRAve	TDR-Signal-Level for special applications.
DeltaCount	Number of single measurements which are used for the averaging.
tpAve	Radar time (average) which corresponds to the respective moisture value.

By clicking „**Save**“ the recorded data is saved in a text file in the following path:
\SONO-CONFIG.exe-Pfad\MD\Dateiname

The name of the text file **Statis+SN+yyyymmddHHMMSS.sts** is assigned automatically with the serial number of the probe (SN) and date and time. The data in the text file can be evaluated with Windows-EXCEL.

5.1.6. “Measure” run in Datalogger-Operation

In the menu **"Measure"** it is possible to aquire and store measurement data from several SONO probes with variable and longer cycle rates in a datalogger-operation, e.g. to store measurement data during a long-term drying cycle.

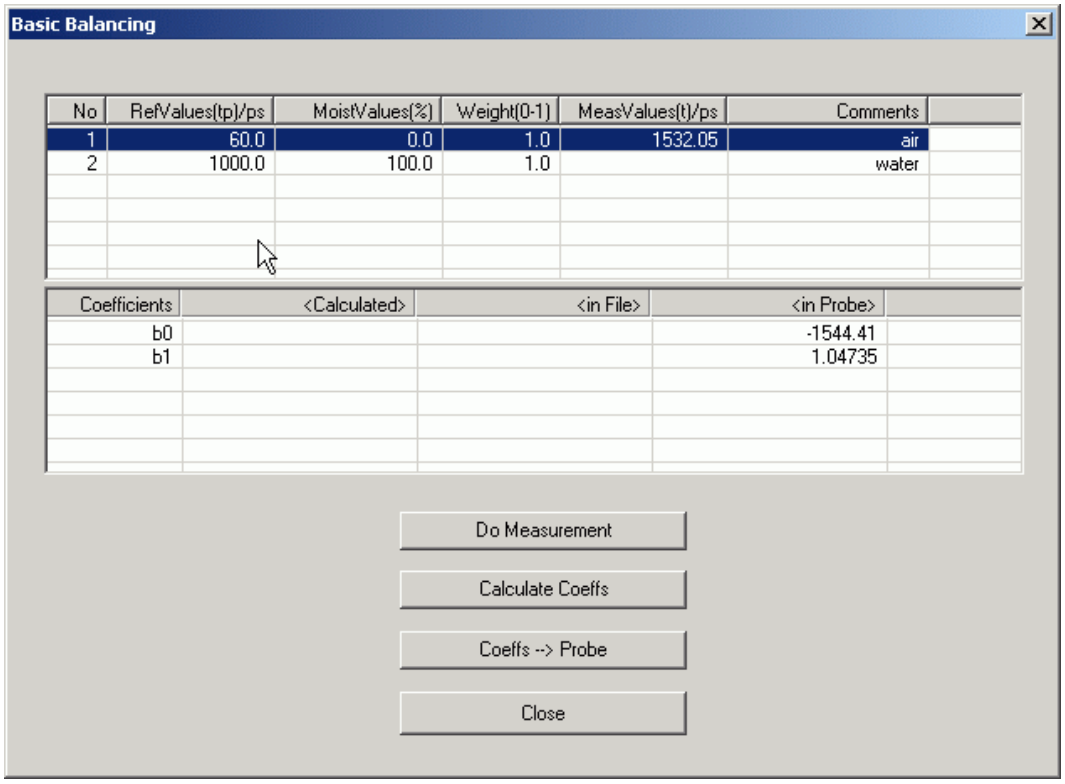
5.1.7. Basic Balancing in Air and Water

SONO probe heads are identical and manufactured precisely. After an exchange of a probe head it is nevertheless advisable to verify the calibration and to check the basic calibration and if necessary to correct it with a “Basic Balancing”.
With a “Basic Balancing” two reference calibration measurements are to be carried out with known set-points ("RefValues"). For the reference media, different calibration materials are used, dependent on the SONO probe type. For SONO probes with a ceramic measurement window, air and water (tap water) is used. For other SONO probes like SONO-GS1 glass beads are used for basic calibrations (on request).

Attention: Before performing a “Basic Balancing” it must be ensured that the SONO probe was set to “Measure Mode” A. If this is not assured, the probe returns zero values. After a “Basic Balancing” the SONO probe has to be set to “Measure Mode C” again, because otherwise the probe would not measure continuously!

In the menu **"Calibration**" and the window "**Basic Balancing**" the two set-point values of the radar time **tp** are displayed with 60ps and 1000ps.

1. Reference set-point A: **tp**=60ps in air (the surface of the probe head must be dry!!)
   The first set-point can be activated with the mouse pointer by clicking to No.1. By activating the button "**Do Measurement**" the SONO probe determines the first reference set-point in air. In the column „MeasValues“ the measured raw value of the radar time **t** is displayed (e.g. 1532.05 picoseconds).
2. Reference set-point B: **tp**=1000ps in water. The SONO probe head has to be covered with water in a height of about 50mm. The second set-point can be activated with the mouse pointer by clicking to No.2. By activating the button "**Do Measurement**" the SONO probe determines the second reference set-point in water. In the column „MeasValues“ the measured raw value of the radar time **t** is displayed.
3. By activating the button „**Calculate Coeffs**“ and „**Coeffs → Probe**“ the alignment data is calculated automatically and is stored in the SONO probe non-volatile. With a “Test run” (in Mode A) the radar time **tp** of the SONO probe should be now 60ps in air and 1000ps in water.



6. Installation of the Probe

The installation conditions are strongly influenced by the constructional circumstances of the respective mixer types. The ideal installation location must be established individually. The following guidelines should hereby be observed.

6.1. Assembly Instructions

The following instructions should be followed when installing the probe:

- The installation locations may not be situated beneath the inlets for additives, water and cement.
- In case of an uneven base, the probe must be installed at the highest point of the base. No water may accumulate at the probe head as this could falsify the measurement.
- Areas with strong turbulences are not ideal for the installation. There should be a continuous material flow above the probe head.
- The stirring movement of the mixer blades should be conducted without gap above the probe head.
- The probe should not be installed in the direct vicinity of electrical disturbing sources such as motors.
- The probe may not project into the mixer. The installation height of the probe may possibly have to re-adjusted due to wear of the mixer blades, arms and the mixer base. No material may deposit on the probe head as this could falsify the measurement.
- In case of curved installation surfaces in the mixer, the centre of the probe head should be flush with the radius of the mixer wall without disturbing the radial material flow in the mixer. The probe may not project and come in contact with blades or wipers.

Attention! Risk of Breakage!

The probe head is made of hardened special steel and a very wear-resistant ceramic in order to warrant for a long life-span of the probe. In spite of the robust and wear-resistant construction, the ceramic plate may not be exposed to any blows as ceramic is prone to breakage.

In case of welding work at the plant, all probes must be completely electrically disconnected.

Any damage caused by faulty installation is not covered by the warranty!

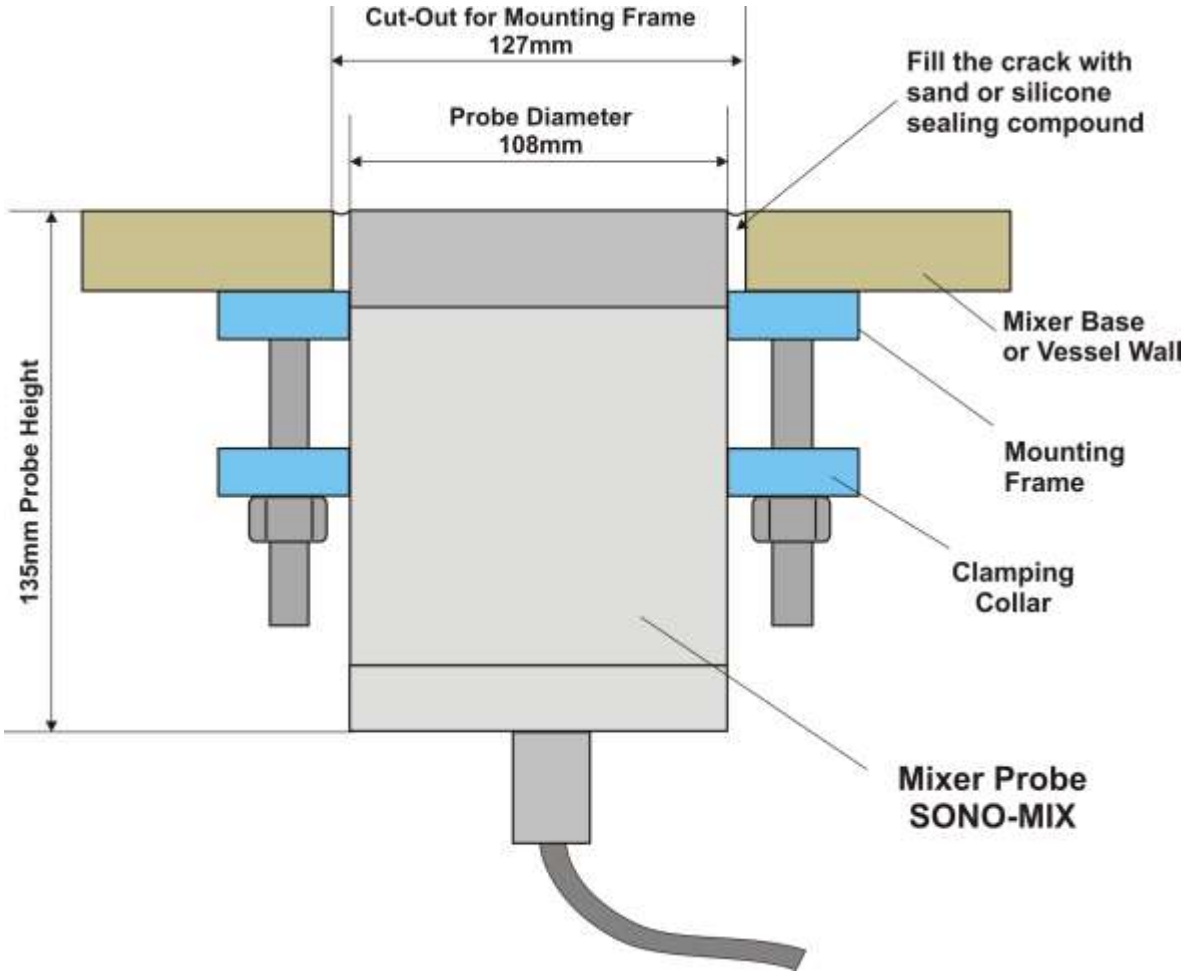
Abrasive wear of sensor parts is not covered by the warranty!

6.2. Assembly Dimensions

SONO-MIX MINI can either be installed at the base or the side wall of a mixer. One fact to consider is that the installation into the mixer base also enables the measurement of smaller material quantities.

A pre-assembled mounting frame is available for the SONO-MIX MINI. The frame can both be welded on to the base and the side wall of the mixer. The probe can be adjusted to the correct position, respectively correct installation height with adjusting screws and nuts at the clamping collar.

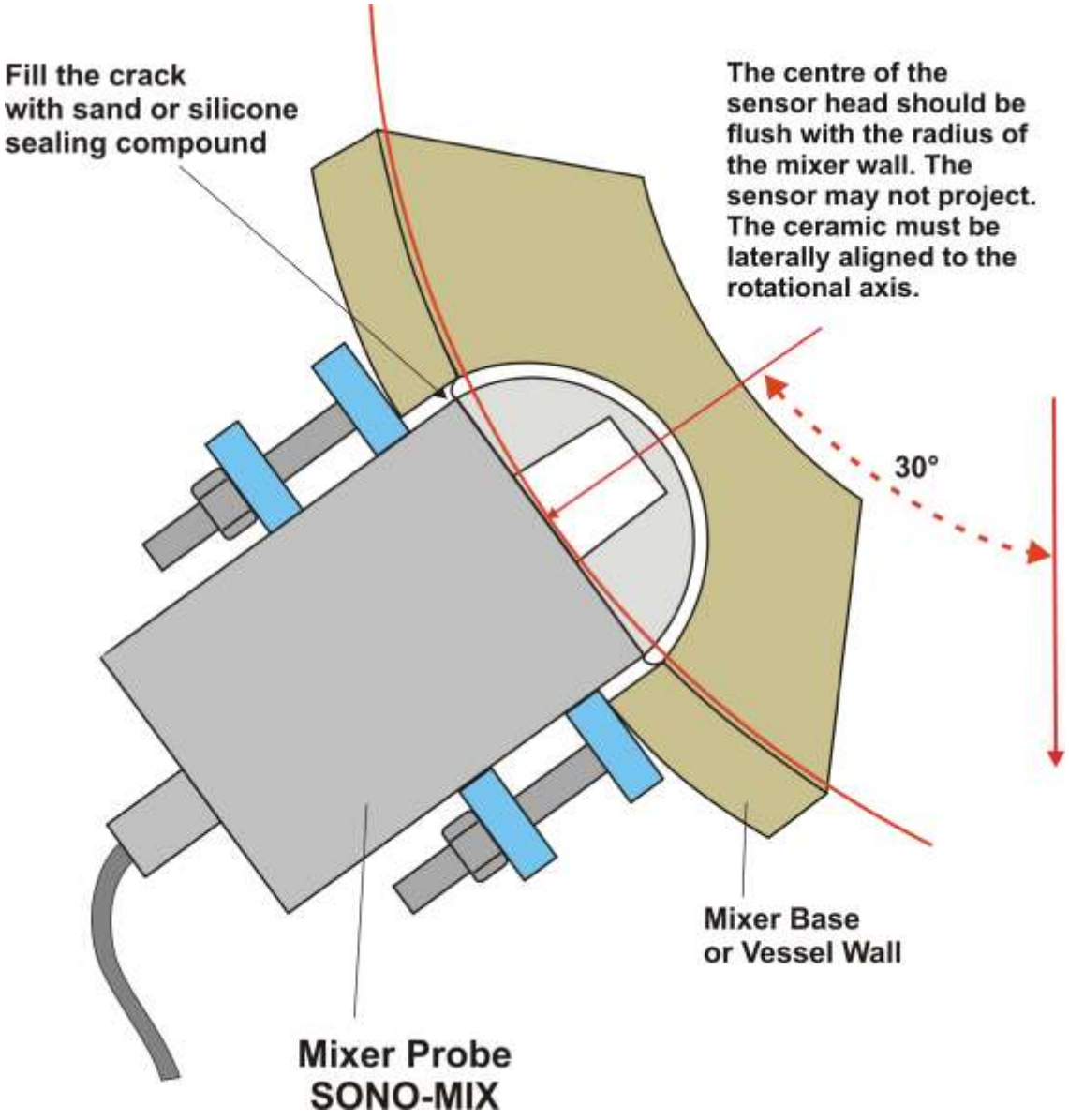
A cut-out must be performed in the mixer base before welding on the mounting frame and it is necessary to verify the fit of the frame and the probe at the base, respectively the wall.



6.3. Mounting in curved Surfaces

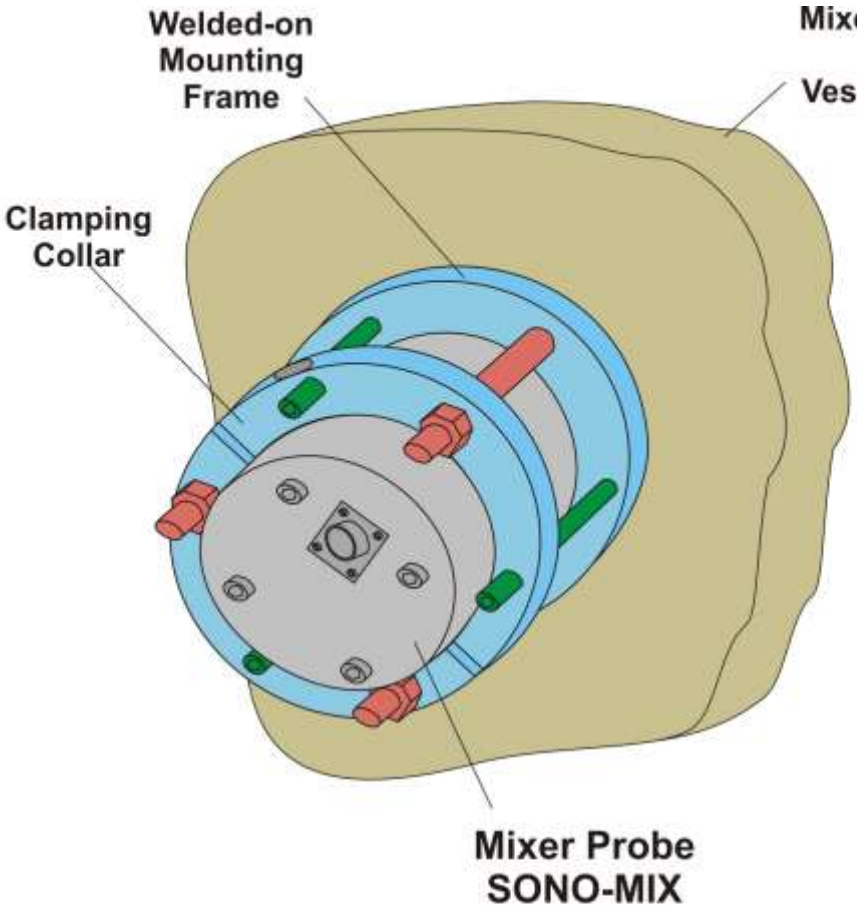
In order to prevent the probe head from projecting and interfering with the mixer blades, the centre of the probe head should be flush with the radius of the mixer wall. The ceramic must be laterally aligned to the rotational axis as the gap towards the mixer blade is smallest in this position.

In order to ensure that the probe head is completely covered with material, the probe is best positioned near the base. In order to prevent water from accumulating above the sensor head, which could falsify the measurement, an installation angle of approximately 30° above the base centre is recommended.



6.4. Probe Adjustment

SONO-MIX MINI can either be installed at the base or the side wall of a mixer.
It may not project into the mixer and should have the same height position as the wear plates in the mixer.



Moving the Probe out of the Mixer:

1. Remove the compressed sand in the crack
2. Loosen the 3 red nuts
3. Fasten the green screws to the desired position using an Allen key
4. Fasten the red nuts
5. Compress the sand in the crack

It may be necessary to newly position the clamping collar.

Moving the Probe into the Mixer:

1. Remove the compressed sand in the crack
2. Screw out the green screws as far as required
3. Tighten the red nuts until the desired position is reached
4. Fasten the three green screws
5. Tighten all nuts
6. Compress the sand in the crack

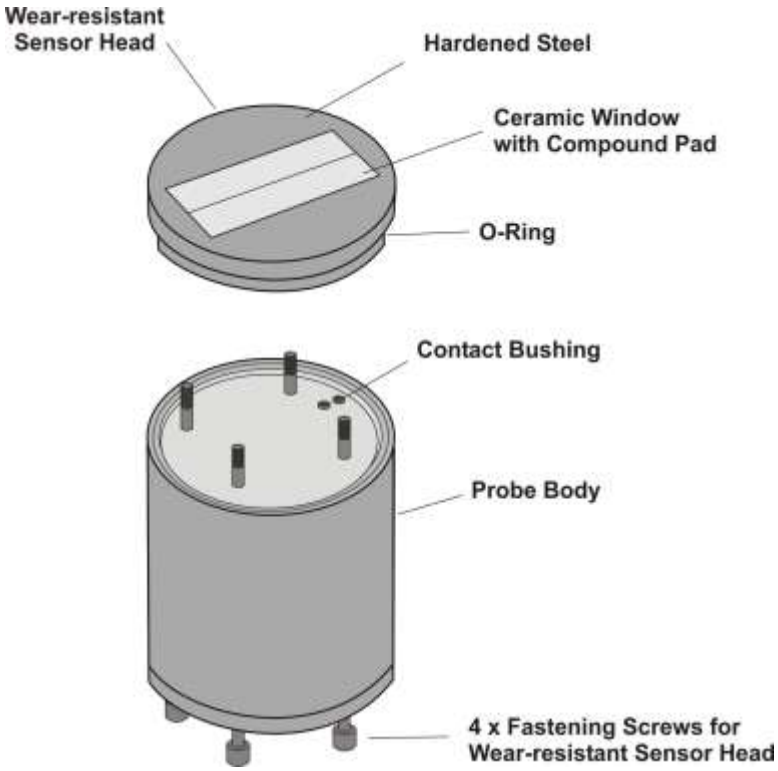
It may be necessary to newly position the clamping collar.

6.5. Exchange of the Probe Head

At the SONO-MIX MINI, not only the ceramic plate but the whole metal/ceramic wear-resistant probe head can be exchanged.

This is how easy it is to exchange the wear-resistant probe head of the SONO-MIX MINI:

- Loosen the 4 fastening screws (look for the right sequence of washer and gasket rings).
- Lift off the probe head carefully so that the robust spring contacts in the interior are canted as little as possible.
- Clean the surface inside the probe body for the O-Ring.
- Place on the probe head so that the two spring contacts are inserted in the contact bushings.
- Screw the 4 fastening screws back on. It is to consider, that the 4 screws “find” the 4 holes in the green epoxy plate inside the probe.



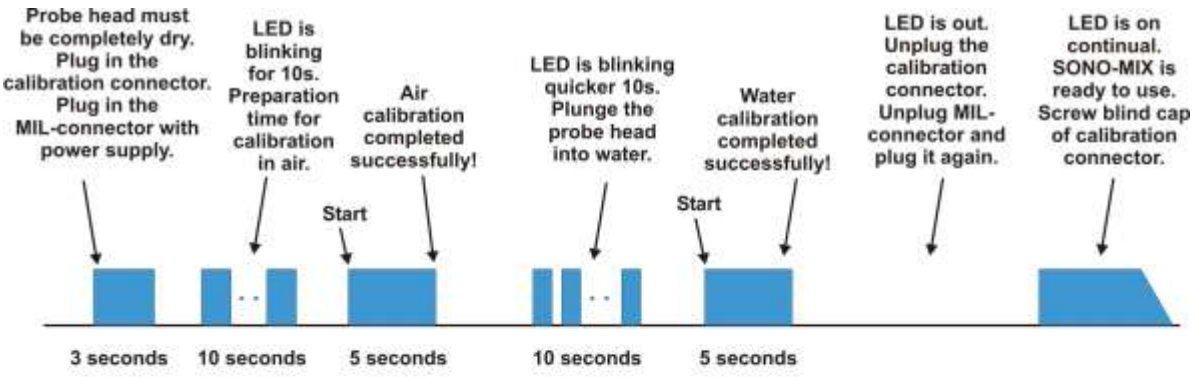
6.5.1. Basic Balancing of a new Probe Head

The probe heads are all identical and are manufactured to fit precisely. In spite of this fact, after an exchange it is necessary to make a basic calibration in air and water, that SONO-MIX MINI measures precise and accurate with the new probe head. Therefore some work-steps are required.

Basic calibration procedure:

1. Provide a small container with water in which the probe head can be plunged in. For the first calibration point in air the **probe head must be completely dry**. If appropriate dry it with a towel.
2. Unplug the blind cap of the calibration connector and plug in the calibration connector.
3. Plug in the MIL-connector with power supply to the probe. The blue LED is on for 3 seconds and start with a slow blinking for the next 10 seconds preparation time for the first point in air. Therefore the dry probe head must be free in air. When the LED is on continual for 5 seconds the calibration is completed in air.
4. Now the blue LED starts with a quicker blinking during 10 seconds preparation time for the second point in water. During this 10 seconds the probe head must plunged in water. When the LED is on continual for 5 seconds the calibration is completed in water. After that the LED is off.
5. If the calibration should be failed, the blue LED will be blinking continual.
6. Unplug the MIL connector and the calibration connector. Plug in the blind cap of the calibration connector. Plug in the MIL connector again. The blue LED should be on continual now. SONO-MIX MINI is ready to use. With strong pressing of a hand to the probe head, the analogue moisture output 4..20mA should be respond.

   If necessary the basic balancing procedure could be repeated several times.


Probe head must be completely dry. Plug in the calibration connector. Plug in the MIL-connector with power supply.
LED is blinking for 10s. Preparation time for calibration in air.
Air calibration completed successfully!
Start
LED is blinking quicker 10s. Plunge the probe head into water.
Water calibration completed successfully!
Start
LED is out. Unplug the calibration connector. Unplug MIL-connector and plug it again.
LED is on continual. SONO-MIX is ready to use. Screw blind cap of calibration connector.
3 seconds
10 seconds
5 seconds
10 seconds
5 seconds

7. TECHNICAL DATA SONO-MIX MINI

SENSOR DESIGN

Casing: High Grade Steel V2A 1.4301

Exchangeable especially wear-resistant sensor head: Tungsten carbide plate with highly wear resistant ceramic window.

MOUNTING

Sensor Dimensions: 108 x 132mm (Diameter x Length)
The mounting and fastening frame can be mounted to the rear side of the mixer base or the outer wall of the mixer. For this purpose, it is adjusted with the help of the additional welded on mounting frame. This enables the easy mounting and dismounting as well as the adjustment of the sensor position in case of wear at the mixer base.

MEASUREMENT RANGE MOISTURE

SONO-MIX MINI measures from 0% up to the point of material saturation.
Measurement ranges up to 90% moisture are possible with a special calibration.

MEASUREMENT RANGE CONDUCTIVITY

The sensor, as a material-specific characteristic value, delivers the radar-based conductance (RbC – **R**adar-**b**ased-**C**onductance) in a range of 0…50dS/m. The conductivity range is reduced in moisture measurement ranges >50%.

MEASUREMENT RANGE TEMPERATURE

Measurement Range: 0°C …70°C
The temperature is measured at the sensor casing beneath the wear-resistant sensor head and can optionally be issued at the analogue output 2. The material temperature can be measured with an external calibration and compensation of the sensor intrinsic-heating.

MEASUREMENT FIELD EXPANSION

Approximately 50 - 80 mm, depending on material and moisture.

POWER SUPPLY

+7V to +24V DC, 1.5 W max.

AMBIENT CONDITIONS

0 - 70°C
A higher temperature range is available upon request!

MEASUREMENT MODE WITH DATA-PREPROCESSING

SONO-MIX MINI can be set to different measurement modes:
MEASUREMENT MODE CS: (Cyclic-Successive) For very short measuring processes without floating average with internal up to 100 measurements per second and a cycle time of 200 milliseconds at the analogue output. Measurement mode CS can also be used for getting raw data from the SONO-probe without averaging and filtering.
MEASUREMENT MODE CA: (Cyclic-Average-Filter) For relative short measuring processes with continual average value, filtering and an accuracy of up to 0.1%
MEASUREMENT MODE CF: (Cyclic-Float-Average) for continual average value with filtering and an accuracy of up to 0.1% for very slowly measuring processes, e.g. in fluidized bed dryers, conveyor belts, etc.
MEASUREMENT MODE CK: (Cyclic-Kalman-Filter) Standard setting for SONO-MIX MINI for use in fresh concrete mixer with continual average value, special dynamic Kalman filtering and an accuracy of up to 0.1%.

SIGNAL OUTPUT

2 x Analogue Outputs 0(4)…20mA
Analogue Output 1: Moisture in % (0..20%, variably adjustable)
Analogue Output 2: Conductivity (RbC) 0..50dS/m or optionally the temperature.
In addition, there is the option to split the analogue output 2 into two ranges, into 4...11mA for the temperature and 12...20mA for the conductivity. The analogue output 2 hereby changes over in 5 second cycles between these two (current) measurement windows.

The two analogue outputs can be variably aligned with the SONO-CONFIG software. For a 0-10V DC voltage output, a 500R resistor can be installed.

CALIBRATION

The sensor is provided with a universal calibration for sand. A maximum of 15 different calibrations can be stored. For special materials, variable calibrations with polynomials up to the 5^{th} order are possible and can be downloaded into the sensor with the SONO-CONFIG software (Download per Internet). A zero point correction can be performed easily with the SONO-CONFIG software.

COMMUNICATION

A RS485 interface and the IMP-Bus enables network operation of the probe, whereby a data bus protocol for the connection of several SONO probes to the serial bus is implemented by default. The connection of the probe to industrial busses such as Profibus, Ethernet, etc. is possible via optional external modules (available upon request).

CONNECTOR PLUG

The sensor is equipped with a robust 10-pole MIL flange connector. Ready made connection cables with MIL connectors are available in the lengths 4m, 10m, or 25 m.

Precise Moisture Measurement

in hydrology, forestry, agriculture, environmental and earth science, civil engineering, as well as individual applications!